THE NATION'S WATER RESOURCES 1975-2000

Volume 4: Alaska Region

Second National Water Assessment by the U.S. Water Resources Council

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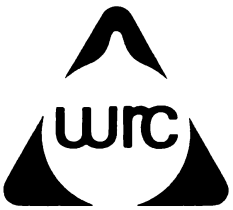

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FOREWORD

The Water Resources Planning Act of 1965 (Public Law 89-80) directs the U.S. Water Resources Council to maintain a continuing study of the Nation's water and related land resources and to prepare periodic assessments to determine the adequacy of these resources to meet present and future water requirements. In 1968, the Water Resources Council reported the results of its initial assessment. The Second National Water Assessment, a decade later, provides a comprehensive nationally consistent data base for the water resources of the United States. The results of the Second National Water Assessment were obtained by extensive coordination and collaboration in three phases.

Phase I: Nationwide Analysis

The Council member agencies researched, analyzed, and prepared estimates of current and projected water requirements and problems and the implications of the estimates for the future.

Phase II: Specific Problem Analysis

Regional sponsors, one for each of the 21 water resources regions, surveyed and analyzed State and regional viewpoints about (1) current and future water problems, (2) conflicts that may arise in meeting State and regional objectives, and (3) problems and conflicts needing resolution.

Phase III: National Problem Analysis

The Council conducted this final phase in three steps: (1) An evaluation of phases I and II, (2) an analysis that identified and evaluated the Nation's most serious water resources problems, and (3) the preparation of a final report entitled "The Nation's Water Resources--1975-2000."

The final report of the Second National Water Assessment consists of four separate volumes as described below. These volumes can assist Federal, State, local, and other program managers, the Administration, and the Congress in establishing and implementing water resources policies and programs.

Volume 1, Summary, gives an overview of the Nation's water supply, water use, and critical water problems for "1975," 1985, and 2000 and summarizes significant concerns.

Volume 2, Water Quantity, Quality, and Related Land Considerations, consists of one publication with five parts:

Part I, "Introduction," outlines the origin of the Second National Water Assessment, states its purpose and scope, explains the

numerous documents that are part of the assessment, and identifies the individuals and agencies that contributed to the assessment.

Part II, "Water-Management Problem Profiles," identifies ten general water problem issues and their implications and potential consequences.

Part III, "Water Uses," focuses on the national perspectives regarding existing ("1975") and projected (1985 and 2000) requirements for water to meet offstream, instream, and flow-management needs. State-regional and Federal perspectives are compared.

Part IV, "Water Supply and Water Quality Considerations," analyzes the adequacy of fresh-water supplies (ground and surface) to meet existing and future requirements. It contains a national water budget; quantifies surface- and ground-water supplies, reservoir storage, and transfers of water within and between subregions; describes regional requirements and compares them to supplies; evaluates water quality conditions; and discusses the legal and institutional aspects of water allocation.

Part V, "Synopses of the Water Resources Regions," covers existing conditions and future requirements for each of the 21 water resources regions. Within each regional synopsis is a discussion of functional and location-specific water-related problems; regional recommendations regarding planning, research, data, and institutional aspects of solving regional water-related problems; a problem-issue matrix; and a comparative-analysis table.

Volume 3, Analytical Data, describes the methods and procedures used to collect, analyze, and describe the data used in the assessment. National summary data are included with explanatory notes. Volume 3 is supplemented by five separately published appendixes that contain data for the regions and subregions:

Appendix I, Social, Economic, and Environmental Data, contains the socioeconomic baseline ("1975") and growth projections (1985 and 2000) on which the water-supply and water-use projections are based. This appendix presents two sets of data. One set, the National Future, represents the Federal viewpoint; the other set, the State-Regional Future, represents the regional sponsor and/or State viewpoint.

Appendix II, Annual Water Supply and Use Analysis, contains baseline water-supply data and baseline and projected water withdrawal and water-consumption data used for the assessment. Also included are a water adequacy analysis, a natural flow analysis, and a critical-month analysis.

Appendix III, Monthly Water Supply and Use Analysis, contains monthly details of the water-supply, water-withdawal, and water-

consumption data contained in Appendix II and includes an analysis of monthly water adequacy.

Appendix IV, Dry-Year Conditions Water Supply and Use Analysis, contains both annual and monthly baseline and projected water-withdrawal and water-consumption data for dry conditions. Also, a dry conditions water-adequacy analysis is included.

Appendix V, Streamflow Conditions, contains detailed background information on the derivation of the baseline streamflow information. A description of streamflow gages used, correction factors applied, periods of record, and extreme flows of record, are given for each subregion. Also included is the State-Regional Future estimate of average streamflow conditions.

Volume 4, Water Resources Regional Reports, consists of separately published reports for each of the 21 regions. Synopses of these reports are given in Volume 2, Part V.

For compiling and analyzing water resources data, the Nation has been divided into 21 major water resources regions and further subdivided into 106 subregions. Eighteen of the regions are within the conterminous United States; the other three are Alaska, Hawaii, and the Caribbean area.

The 21 water resources regions are hydrologic areas that have either the drainage area of a major river, such as the Missouri Region, or the combined drainage areas of a series of rivers, such as the South Atlantic-Gulf Region, which includes a number of southeastern States that have rivers draining directly into the Atlantic Ocean and the Gulf of Mexico.

The 106 subregions, which are smaller drainage areas, were used exclusively in the Second National Water Assessment as basic data-collection units. Subregion data point up problems that are primarily basinwide in nature. Data aggregated from the subregions portray both regional and national conditions, and also show the wide contrasts in both regional and national water sources and uses.

The Second National Water Assessment and its data base constitute a major step in the identification and definition of water resources problems by the many State, regional, and Federal institutions involved. However, much of the information in this assessment is general and broad in scope; thus, its application should be viewed in that context, particularly in the area of water quality. Further, the information reflects areas of deficiencies in availability and reliability of data. For these reasons, State, regional, and Federal planners should view the information as indicative, and not the only source to be considered. When policy decisions are to be made, the effects at State, regional, and local levels should be carefully considered.

In a national study it is difficult to reflect completely the regional variations within the national aggregation. For example, several regional

reviewers did not agree with the national projections made for their regions. These disagreements can be largely attributed either to different assumptions by the regional reviewers or to lack of representation of the national data at the regional level. Therefore, any regional or State resources-management planning effort should consider the State-regional reports developed during phase II and summarized in Volume 4 as well as the nationally consistent data base and the other information presented in this assessment.

Additional years of information and experience show that considerable change has occurred since the first assessment was prepared in 1968. The population has not grown at the rate anticipated, and the projections of future water requirements for this second assessment are considerably lower than those made for the first assessment. Also, greater awareness of environmental values, water quality, ground-water overdraft, limitations of available water supplies, and energy concerns are having a dramatic effect on water-resources management. Conservation, reuse, recycling, and weather modification are considerations toward making better use of, or expanding, available supplies.

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Illustrations

Physiography

Description

Alaska has an area of 586,000 square miles. With a diversity of land forms and ecosystems, it embraces one-sixth the area of the United States. Alaska is a maritime State having about 46,300 miles of coastline. Almost all its people live in close proximity to the sea coast and the major rivers (Figure 19-1).

Of the several major river systems in the State, the Yukon River Basin is the largest. It has a drainage area of about 205,000 square miles, about 35 percent of the State's total area. Other major river systems include the Copper, Susitna, Kuskokwim, Kobuk, Noatak, and Colvill. There are extensive natural lake systems in some parts of the State, including Lake Illiamna, which has a surface area of 1,000 square miles. Inland lakes and riverine systems encompass 5.1 million acres and 7.7 million acres, respectively, or a little over 3 percent of the total area of the State (Figure 19-2).

Topography

Much of the State is mountainous, and the combination of mountains, northerly latitudes, and extensive coastlands provides further interesting contrasts. For example, the lowland areas in southeast and southcentral Alaska enjoy a moderate climate due to maritime influences. However, these same areas include extensive glaciers and ice fields and at elevations of 2,000 feet to 3,000 feet above sea level exhibit all the characteristics of very cold alpine climate ecosystems.

The continuous permafrost that exists over roughly the northern third of the region and the discontinuous permafrost that extends over parts of the southwest and south-central subregions present difficult water supply problems.

Climate

The geographical features have a significant bearing on the region's varied climate. A zone of maritime influence extending throughout southern Alaska along the Gulf Coast experiences a mild, wet climate. Annual precipitation amounts at sea level in this area are generally above 60 inches and at some stations as high as 200 inches. The rugged mountains in the southeast areas and along the coast of the Gulf of Alaska in the southcentral areas experience even higher precipitation. These areas contain the principal glaciers of the State.

Away from the zone of maritime influence, the climate changes rapidly, with decreasing amounts of precipitation and greater extremes of temperature. Average annual precipitation in the interior areas is about 12 inches

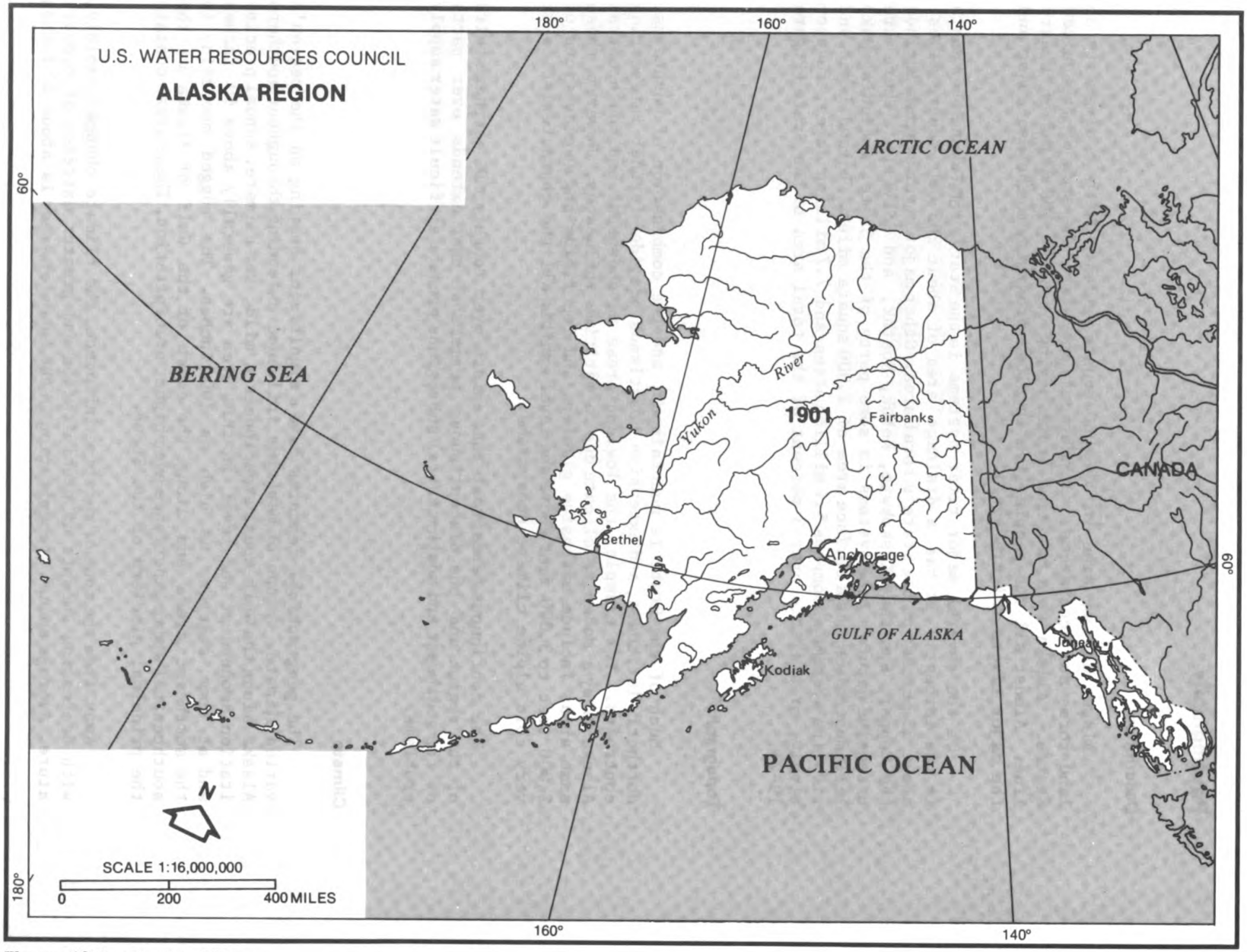


Figure 19-1. Region Map

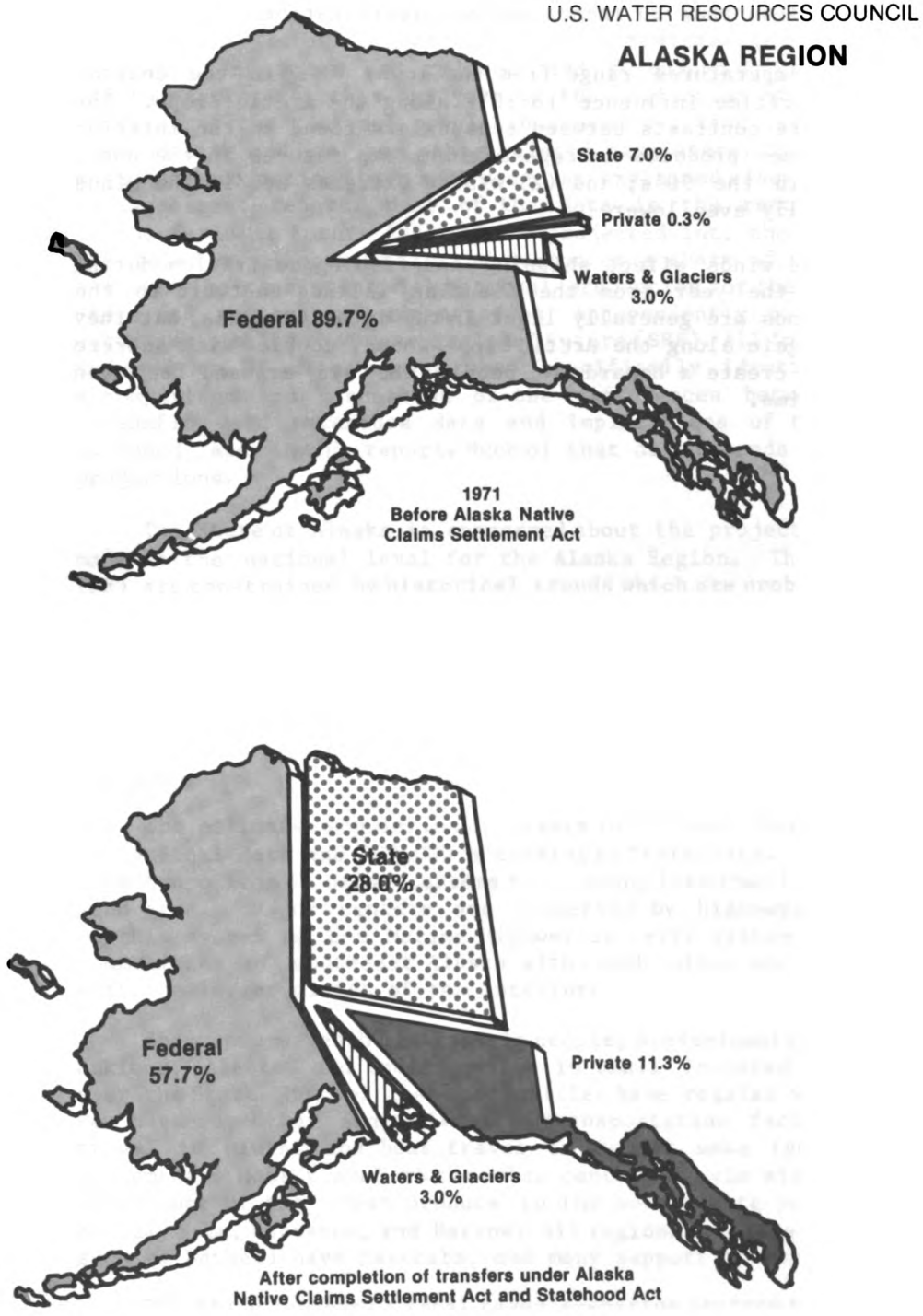


Figure 19-2. Present Land Use

and along the Arctic Slope usually six inches or less; however, the mountainous areas have considerably more. The vast majority of Alaska (66 percent) receives less than 20 inches annual precipitation.

Mean annual temperatures range from the lower 40's in the coastal areas under the maritime influence to 10°F along the Arctic Slope. The greatest temperature contrasts between seasons are found in the interior areas where (1) summer produces average maximum temperatures in the upper 70's and extremes in the 90's; and (2) winter extremes are in the minus 50's and occasionally even lower.

Strong surface winds affect shipping and fishing activities during about 8 months of the year from the Aleutian Islands eastward to the Gulf of Alaska. Winds are generally light in the interior areas, but they become a problem again along the Arctic Slope where, coupled with subzero temperatures, they create a hazard to people who are exposed for even short periods of time.

People and the Resources

An analysis of current and future activities is basic to any identification of water and related land resources in the Alaska Region. The foundation for this analysis is the collection of estimates and projections of the regional population, economy, land use, water resources, availability and use, and other related parameters. These and other estimates and projections have been made, as explained elsewhere in the national assessment report. Most of the data in the report are referred to as the National Future (NF). Where projected into the future, these data are based on allocation to the region of a share of national production and service consistent with national projection for the Nation as a whole. State and regional representatives independently provided alternative estimates, called the State-Regional Future (SRF). All information presented is based on NF data except when specifically identified as SRF data. A comparison and discussion of the differences between NF and SRF on streamflow and water-use data and implications of the variations are included later in this report. Much of that data depends upon socioeconomic projections.

The State of Alaska is concerned about the projections that have been made at the national level for the Alaska Region. The National Futures (NF) are constrained by historical trends which are probably not applicable as such to that State. On the other hand, State-Regional Futures (SRF) tend to be confused by possible institutional constraints and uncertainties. Hence, it has been decided to present both sets of values for the benefit of planners in the State, who will be evaluating changing conditions in the years ahead.

Population

The estimated population of Alaska in 1975 was about 307,000 according to national data and 409,000 according to State data. Most Alaskans live in metropolitan or urban centers that occupy less than 1 percent of Alaska's land area. Major centers are connected by highways. A unique part of this system is the Marine Highway or ferry system which connects the communities of southeast Alaska with each other and via road systems, with the larger cities of the interior.

About one-seventh of Alaska's people, predominantly native Alaskans--Eskimos, Aleuts, and Indians--live in small isolated villages scattered over the State. Most of these communities have regular weekly air service. Few have any other long distance transportation facilities. Over-snow travel in winter and boat travel in summer make family visits fairly economical. Most travel to the urban centers is via air, and the airlines carry most of the fresh produce to the more remote population centers--Bethel, Nome, Kotzebue, and Barrow. All regional centers (even remote places such as Bethel) have taxicabs, and many support bus service.

The State supports a local revenue-sharing program to further community services such as health care, police and fire protection, and education. Police and fire protection is common to all communities in accordance with expressed need. Alaskans support two universities as well as a highly-

regarded public education system. Secondary education for students living in remote villages has shown some improvement with the construction of boarding facilities in some of the larger regional communities. Recently, Alaska has begun construction of high school facilities in smaller remote communities to enhance family and community ties.

Water supply and waste disposal within the major urban centers are on a par with those found in the contiguous United States. However, in the remote native communities, water supply and waste disposal are serious problems. Very few of the villages have a safe, dependable, and satisfactory water supply, and this supply may be available only at a central watering point. Most of the larger native villages now have electric powerplants and local distribution systems.

Alaska's population continues to be young and mostly outdoor oriented. The 1970 census (latest figures available) shows a median age of 22.9 years with 39.9 percent of the population being under 18 years of age. Median age for males was 23.3 and for females 22.2 years. The male/female ratio, which is traditionally weighted toward the male side in any frontier setting, is leveling off. Though pipeline construction may affect this balance temporarily, there are now only 119 males to every 100 females.

The National Future projection of population for the year 2000 is 438,000. While this is a 43 percent increase compared to the 1975 NF estimate, it is only 7 percent higher than the State's estimate of population in 1975. The State forecasts a population of 992,000 in 2000. Energy development will probably encourage more immigration than anticipated in the NF estimates.

Alaskans have a long tradition of environmental awareness. They show a deep concern for protecting and utilizing their vast resources of timber, fish, oil and gas, minerals, wilderness, wildlife, and recreation.

Economy

Alaska has experienced remarkable growth over the last few years primarily because of expansion in the energy industry. The trans-Alaska oil pipeline project has caused dramatic changes in Alaska's social and economic structure, and there have been few areas in the State that have not been affected in some manner by this multibillion dollar project. Growth in State and local government has also been an important factor in the growth of the economy.

Total earnings, derived from OBERS projections (NF) climbed to about $2.2 billion in 1975, an increase of 19 percent from the 1970 level (Table 19-1). Personal income grew from almost $2.0 billion in 1974 to about $2.3 billion in 1975, an increase of about 18 percent.

During 1976, the Alaskan economy experienced the crest of the oil pipeline construction surge. After posting a record rate of economic growth in 1975, the expansion continued into 1976, albeit at a much slower rate. While the trans-Alaska oil pipeline continued to be the primary stimulus, other industries, such as wood products and fisheries, contributed to the general upward growth trend. The native regional corporations were also very active in 1976, with investments in hotels,

Table 19-1.--Alaska Region earnings--1975, 1985, 2000
(million 1975 dollars)

Earnings sector	1975	1985	2000
Manufacturing	144	207	330
Agriculture	28	34	44
Mining	55	86	138
Other	1,925	2,837	4,941
Total	2,152	3,164	5,453

real estate, the timber and fishing industries, a major housing development, oil, gas, and mineral exploration, and in local manufacturing operations. In addition, some of the regional corporations are constructing buildings to house their corporate headquarters.

The upturn in the economies of Japan and the United States is having a positive impact on Alaska's wood products industry. The production and the export of wood products were both up slightly on an annual basis during 1976, and the industry did not suffer the mill shutdowns for "inventory adjustments" that were prevalent in 1975. Additionally, the favorable settlement of the "clearcutting ban" issue and the environmental problems at Ketchikan Pulp Mill, which might have shut the mill down, added a degree of stability to the otherwise clouded outlook of the wood products industry.

Both the volume and value of the seafood harvested recorded substantial gains during 1976. An increased fish and shellfish harvest stimulated employment in the food processing sector of the manufacturing industry. Commercial fishing alone accounted for over a $300 million industry.

Activity in the petroleum industry continued upward at a sharp pace during 1976. As the pipeline neared completion, the tempo of developmental well drilling activity at Prudhoe Bay quickened. Exploration activities were underway by the fall of 1976 on the Outer Continental Shelf (OCS), while a lower Cook Inlet lease sale was held in late 1977. Mineral activity continued during the year with the announced discovery of a major molybdenum ore body in southeastern Alaska, copper in the southern Brooks Range, and rare earth elements in the Seward Peninsula.

The part of Alaska's construction industry not related to the pipeline appears to be going through a period of readjustment from the high levels experienced during the past few years. However, commercial and industrial construction has recorded a moderate gain, indicating a continuing strength in this sector.

Economic activity in 1977 and 1978 continued at about the level experienced in 1975, while remaining substantially higher than in pre-pipeline years. Alaska's long-run economic future will be determined by State, national, and international decisions, including the mix and timing of a number of economic development activities. Probable activities include the OCS development, the natural gas pipeline, the investment activities of the native corporations and the Permanent Fund, the development of Alaska's agricultural potential, the use of the Haines-Fairbanks pipeline,

the development of a cement plant, and the development of Alaska's hard mineral resources.

Subsistence

Alaska's rural, predominately native population is heavily dependent upon a subsistence rather than a cash economy. Subsistence resources and uses depend upon the preservation and protection of fish and wildlife habitat, migration patterns, spawning beds, etc. and a low human population density. Seventy-five percent of the subsistence resource harvested comes from the marine environment, mainly in the form of salmon.

The subsistence economy exists not only because it is the traditional use of available resources, but because there has been no available replacement. At a minimum, the cash equivalent or replacement cost of food gathered through subsistence activities by rural Alaska natives has been estimated at over $65 million annually. Even assuming the desirability of such replacement, the cash economy to replace that scale of subsistence economy simply does not exist in rural Alaska. While government employment and welfare assistance have enlarged the cash economy in rural Alaska recently, there is no assurance that subsistence can be supplanted as a major economic base in rural Alaska.

Native corporation investment and employment opportunities are beginning to inject some cash into the rural economy, but subsistence will continue to dominate the economy, due at least partially to personal and social preferences, as well as to economic pressures. There is no question that certain elements of a cash economy are inevitable and probably desirable.

Water and land-use decisions and demographic changes will determine whether a viable subsistence economy can continue to exist. An increasing population and development of oil and other mineral resources potentials could engender problems of water degradation and habitat destruction and could cause irreversible, adverse effects on the subsistence resources. Sudden changes in the existing economic structure could result in corresponding dislocation of the social order.

The resolution of subsistence versus other uses of lands and waters is obviously complex and difficult. The importance of the subsistence resources and uses in Alaska must be considered in water and related land resources planning and development.

Natural Resources

Alaska has a vast treasury of resources including water, land, forests, minerals, fish and wildlife, coal, oil and gas, and other energy potential. It contains one of the largest areas of untouched wilderness in the world. It is the summer nursery of myriad species of migratory birds and sea mammals which roam as far as Mexico, Tahiti, Japan, and Australia. Alaska provides necessary habitat for species of exceptional flora and fauna. Scenic beauty is provided by North America's highest peak, Mount McKinley, the fjorded and glaciated mountains of southeast Alaska, the jagged, sawtoothed mountains of the Brooks Range, and the lake-interspersed tundra of the North

Slope, carpeted with the many-hued wildflowers of summer and by other natural features. Table 19-2 presents estimates of areas of major land uses.

Table 19-2.--Alaska Region surface area and 1975 land use

Surface area or land-use type	1,000 acres	Percentage of total surface area
Surface area		
Total	375,304	100.0
Water	12,787	3.4
Land	362,517	96.6
Land use		
Cropland	21	0
Pasture and range	238,186	63.5
Forest and woodland	58,635	15.6
Other agriculture	29	0
Urban	68	0
Other	65,578	17.5

Land Ownership

Section 17(d)(1) of ANCSA calls for a review of all unreserved public lands in Alaska "to insure that the public interest in these lands is properly protected." In March 1974, the Secretary of the Interior extended the (d)(1) category to include all unreserved and unappropriated public lands in Alaska. Section 7(d)(2) provided for recommendations to the Congress for designation of up to 80 million acres of Alaska land for use as national parks, forests, and refuges and for inclusion of some of Alaska's rivers in the wild and scenic rivers systems. Congress is currently considering a number of recommendations to determine which lands are to be placed in the four traditional systems.

ANCSA provides for some 40 million acres of land to be returned to native ownership. ANCSA also provides for the State to complete selection of its 104 million acre entitlement under the Alaska Statehood act. In addition, there are several major wilderness area proposals within existing parks, forests, and refuges.

Changes in land ownership and land management which will result from ANCSA have significant long-range impact on water and related land development in Alaska. These changes will include encouraging water and related land developments in some areas, and discouraging or prohibiting such developments in others.

The land to be returned to native ownership represents about 11 percent of the State. It has been estimated that this includes 30 to 40 percent of the consumable natural resources and a significant percentage of the lands adjacent to the major water courses, as well as approximately 30 percent of the State's coastline.

Agriculture

Food

Agriculture in the traditional sense is a small component of the Alaska economy. Currently only about 20,000 acres are being farmed; however,

livestock operations including beef and dairy cattle, sheep, hogs, and reindeer use additional land (Table 19-3).

Table 19-3.--Projected changes in cropland and irrigated farmland in the Alaska Region--1975, 1985, 2000
(1,000 acres)

Land category	1975	1985	2000
Total cropland ----------	21	35	37
Cropland harvested --------	17	25	25
Irrigated farmland --------	4	4	4

Existing agricultural development is very small compared to the potential. Alaska is predominantly a food-dependent State producing less than 15 percent of the food consumed within its borders. The agricultural community has identified a little over 18 million acres of potentially productive arable soils within climatic zones. These areas will also provide important opportunities for expanded livestock operations. Many people feel that substantial expansion in agriculture will occur in this century.

The State has initiated a pilot program for large scale barley production in the delta area of the interior. Water implications include development of adequate water supplies for farming and livestock and development of new lands with attendant changes in runoff, drainage, and natural habitat.

Forest

Alaska has about 59 million acres of forest and woodland according to NF estimates. These forestlands include over 28 million acres of commercial timberlands that, with the remaining 31 million acres of noncommercial timberlands, provide important watersheds, wildlife habitat, minerals, and recreation, as well as wood products. The State estimates 119 million acres of forest with 28 million acres of commercial timber.

Alaska forests support a significant renewable resource industry. Annual harvest has been on about 16,000 acres of forestland with production averaging about 570 million board feet of wood products having a value of $114 million.

Fish and Wildlife

Alaska is widely recognized as the last stronghold of many naturally occurring wilderness fish and game species in the United States. It supports populations of several uniquely Arctic species, such as the musk ox, caribou, polar bear, and walrus, and many other species, such as the wolf, moose, and grizzly bear, which have been depleted in the conterminous United States.

Alaska's five species of Pacific salmon, several species of crab, shrimp, and halibut support a commercial fishery and accompanying fish and seafood processing industry which are major sources of income in the State. The industry uses significant amounts of water which will increase substantially with the anticipated utilization and processing of bottomfish.

Recreation fishing and hunting, by residents and visitors alike, provide the base for a growing industry centered around guiding, lodges, and air taxi operations. Commercial trapping is another small but important industry based upon these resources.

Energy

Alaska has an exceptional variety of energy alternatives. Oil, gas, coal, uranium, geothermal, hydropower, wind, tidal, and solar resources occur in this region. Currently, oil, gas, coal, and hydropower are being used for power generation and can produce much more energy. To a lesser extent, uranium, geothermal, and wood resources also offer potential for future development. While the geothermal, wind, tidal, solar, and hydropower resources must be used in Alaska, the other energy resources can be used within the State or exported. In fact, intense pressure is occurring in the State for the development of its oil and gas, and for its coal resources, for export to outside markets.

Oil and gas are presently being produced on the Kenai Peninsula and in Cook Inlet at daily rates of approximately 200,000 barrels and 395 million cubic feet, respectively. Production from North Slope fields began in 1977. Gas production of 4.5 million cubic feet per day is expected by the early 1980's; besides these two areas, many other basins in the State exhibit good potential for future discoveries.

According to NF estimates, electric energy production in Alaska totaled 1,427 gigawatt-hours (gWh) in 1975, while anticipated growth reflects a production of 15,423 gWh for the year 2000 (Table 19-4). The SRF projections for the year 2000 are low level of development, 14,900 gWh; and high level of development, 58,000 gWh.

Table 19-4.--Alaska Region electric power generation--1975, 1985, 2000
(gigawatt-hours)

Fuel source	1975	1985	2000
Fossil	1,116	2,073	7,053
Nuclear	0	0	0
Conventional hydropower	311	1,225	8,370
Total generation	1,427	3,298	15,423

Coal is currrently produced at an annual rate of 700,000 tons in the Nenana field south of Fairbanks. The possibility exists for the expansion of coal production from that field as well as the initiation of coal production in the Beluga field west of Anchorage.

Hydroelectric power is produced in relatively small amounts near several southeastern communities and near Anchorage. A potential exists for annual production of 170,000 gigawatt hours of electricity from 76 favorable sites. Studies are underway presently to evaluate the feasibility of several different sites; the largest proposed development would be the Devil Canyon and Watana Dams in the Susitna Basin having a combined potential annual capacity of 6,800 gigawatt hours.

Navigation

Historically, Alaska's waters have not only sustained the lives of its people but have provided a means of communication and commerce. Most com-

munities have been built within easy access of salt or fresh water.

Because of the wide variation of climate, many of Alaska's rivers and ports are available only on a limited basis but when they are open they experience considerable commercial activity. Conversely, the harbors of the Gulf of Alaska and the southeast enjoy year around, ice-free operation. A shallow, frozen stream will often enhance traffic to a remote community via snow vehicles.

The waters of Alaska support a rich and growing fishing industry requiring an ever-increasing number of various size vessels for harvesting processing. These vessels in turn require ports, harbors, maintenance facilities, and well-marked and lighted passages to and from the fishing grounds. Southeast Alaska, with its high mountains and deep fjords, must rely upon the Marine Highway (a ferry system, and barge transportation) for much of its commerce. Recreation boating provides access to many roadless areas and opens these areas for many land-based recreation activities. Again, these activities require harbors, maintenance facilities, and well-marked channels to assure safe passage.

Waterborne transport to, from, and within Alaska has remained fairly stable throughout the 1970's with a small increase around 1972 to accommodate oil pipeline construction. During the first half of this period, the yearly average was slightly over 25 million short tons. Although food and other goods used in the State are, for the most part, transported over water, there are few developed ports in the State. Winter sea ice in the Bering Sea and the Arctic Ocean limits the shipping season there from 2 to 4 months each year.

Alaska generates little backhaul cargo with the exception of fisheries products and timber.

Because of the shallow offshore water and the lack of deep-water ports in the north and northwest, shallow-draft barges and vessels are frequently used. The Bureau of Indian Affairs' motor vessel, North Star, delivers freight to villages on the Bering Sea and the Arctic Ocean twice yearly. Year-round scheduled freight service into the port of Anchorage began in the early 1960's, and the initiation of the use of containerization and sea trains has improved service and reduced costs.

Most of Alaska's multimillion dollar export trade with Japan leaves the State via waterborne carrier. The shortest water route for shipping between the western United States and Japan skirts Alaska's southern coast.

Tourism, which now brings over a quarter of a million travelers to Alaska each year, depends upon the cruise ships for a substantial part of this industry. People continue to be drawn to the State by the lure of clean waters and the fish and wildlife associated with such an unspoiled environment. During 1977, there were an estimated 300,000 travelers to Alaska representing a net gain of some 30,000 over 1976. This level of tourism represents a multimillion dollar industry that is an important part of the State economy. While air travel has become the leader in travel to Alaska, the fastest growing means of transportation to Alaska in the pure vacation market has been cruise ship travel.

Alaska's water resources provide exceptional boating opportunities.

Environment

Alaska embraces an immense natural environment, little altered by humans. There is regional concern for protecting the natural environment while using, but not abusing, natural resources. Of particular concern to many people is the degradation of wetlands in the vicinity of the urban areas. Also, some of the best potential agricultural land is being lost because of its high value for other uses. There is now considerable competition for water related lands.

Existing use of water in its natural state is extremely important, including natural use by fish and wildlife and use by man for transportation, subsistence, and recreation. However, other functional uses tend to be fairly intensive for those areas readily accessible to the major cities. For example, fish and forest products processing utilizes large amounts of water.

It is anticipated that fairly intensive water use will continue to develop in the vicinity of Alaska's cities as well as in the immediate vicinity of major resource developments.

Navigation in waterways, ports, and harbors, is very important for Alaska. The State is dependent on waterborne commerce for much of its production and for importation of commodities used in the State. Further, many communities are accessible only by air or water.

There are presently no large water storage developments in the State. There are a few small dams, and most of the existing ones are in close proximity to the State's larger cities. A sizable flood-control project is nearing completion on the Chena River near Fairbanks. Several hydroelectric projects are under active consideration including the Upper Susitna Project (1.4 million kilowatts) and several smaller projects. The aggregate of the present dams and those under construction or under active consideration would relate to river basin areas involving less than 2 percent of Alaska's land area and the actual reservoirs would involve much less than that.

The resource values and strength of Alaska's economy suggest substantial future increases in population, resource development, and tourism. The region should be prepared for large new water uses for energy projects and for other nonenergy, mineral, and other development.

Water

Alaska has abundant water resources, estimated to be about 42 percent of the Nation's fresh remaining water supply, distributed over more than 16 percent of the Nation's total land area. It is evident that on a total statewide basis, supplies of water substantially exceed demands for total consumptive uses and functions and will continue to do so for the foreseeable future. The apparent availability of water in Alaska, with its myriad lakes and streams, can be deceiving, however. Frequently in some places an

adequate source of water for year-round use may not be available, or needed water may be difficult to obtain. For the vast land areas of Alaska, water is in the form of snow and/or ice for most of the year. The combination of geologic, climatic, seasonal, geographic, and other effects often produces problems and conditions in Alaska for which there are no comparable situations in other parts of the United States. Hence, in many instances it will be necessary to rely on Alaskan experience and methodology in solving problems that are unique to Alaska.

Alaska's low temperatures affect water resource use and management practices. Not only the intensity, but also the duration of cold weather prevailing in many parts of Alaska produces unusual effects. Extensive glaciation and permafrost, as well as thick layers of ice throughout a large part of the year on many of the Alaskan surface waters, preserve a significant part of Alaskan water resources in a nonaccessible state. Permafrost modifies ground-water movement and availability. Shallow lakes may freeze to the bottom or have several feet of ice cover. Low instream flows occur in winter and not in summer. All of these and other conditions place significant geographical and seasonal limitations on the supply of water that is available for use.

On the other hand, the prevalence of low temperatures can be beneficial. If, for example, cooling capacity were chosen as a measure of positive value, the Alaska water resource has an available abundance of inherent worth. Each gallon of water available for cooling purposes in Alaska may have many times the available effect of the same water under temperate or tropical conditions elsewhere. This cooling water example may not be as obvious as some other facets of water availability, but it is no less significant for energy or commercial purposes. Physical, chemical, and biological relationships all play a part in what is considered water resource availability.

Surface Water

All major streams in the region originate in Alaska except for the Yukon and Porcupine Rivers and the Alsek, Taku, and Stikine whose headwaters are in Canada. All of the streams in the region flow into either the Arctic Ocean, Bering Sea, or the Pacific Ocean. (See Figure 19-3.)

The streams in the region fall into two general groups, glacial and nonglacial. Most glacial streams are found in the southcentral and southeast subregions and in the Tanana River Basin.

The Yukon River is the largest in the State and ranks fifth in discharge among streams in the United States. It drains an area of about 327,000 square miles, 35 percent of which is in Canada.

The estimated mean annual discharge is 262,000 cubic feet per second (169,300 mgd), about 36 percent of which flows into the State from Canada. The Yukon River Basin which is in Alaska covers about 36 percent of the State's area.

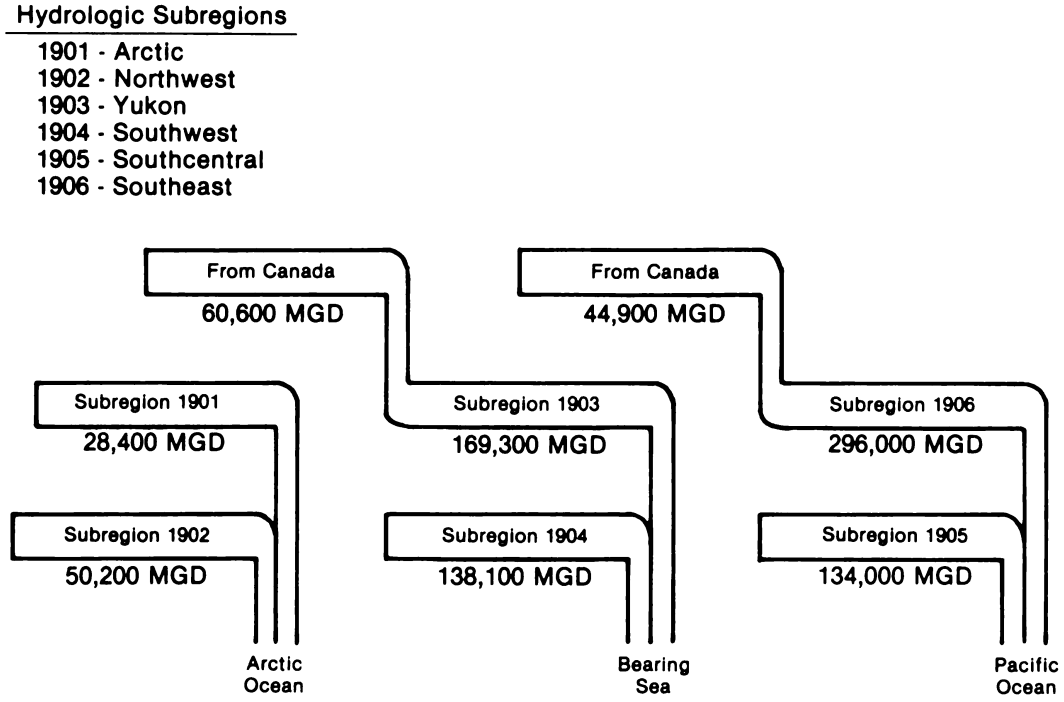


Figure 19-3. Streamflow

The average annual fresh-water outflow from Alaska as derived from NF data amounts to an estimated 905 billion gallons per day. State (SRF) sources estimate a total average annual outflow of only 816 bgd. Both estimates include about 105.5 billion gallons per day inflow from Canada. It should be repeated that the runoff varies considerably during the year with extreme lows encountered during the winter months.

Low-lying areas adjacent to the Gulf of Alaska have high unit runoff and relatively little seasonal variation. Generally, in the mountainous areas adjacent to the Gulf, runoff is high and in the northern part of the region, runoff rates are low.

Alaska has thousands of lakes ranging in size from ponds to the largest lake in the region, Iliamna. In addition to Lake Iliamna, 94 lakes in the region have surface areas in excess of 10 square miles.

Most of the lakes are along the north and west coast of the region in the wet tundra system at or near sea level. Other groups of lakes are in the Central Yukon, Koyukuk, Tanana, Upper Yukon, and Gulf of Alaska subareas. Glacier-fed and glacier-dammed lakes occur along the Alaska Range and the Chugach Mountains.

Ground Water

Ground-water conditions in Alaska are highly variable. Unfrozen, re-

cent alluvial deposits in river valleys, including the flood plains, terraces, and alluvial fans, are the principal aquifers and recharge areas in the State. Alluvium, consisting largely of permeable sand and gravel, ranges in thickness from a few feet in small mountain valleys to about 2,000 feet in the Tanana Valley. Glacial and glaciolacustrine deposits in the interior valleys, particularly the Copper River Basin, are a much smaller source of ground water. Consolidated bedrock is capable of small water yields from fractures and is used locally for water supplies. Ground water also occurs in cavernous carbonate rocks that support large springs. Figure 19-4 illustrates the generalized alluvial aquifers estimated to be capable of supplying wells producing over 1,000 gallons per minute.

The extent and thickness of permafrost limits the availability of ground water. The volume of frozen ground decreases southward consistent with the regional zonation of permafrost with a corresponding increase to the south in the quantity of ground water available. Within the zone of continuous permafrost, unfrozen alluvium is found only under the major streams and beneath lakes deeper than about 7 feet. Ground water is found in some Arctic areas beneath the permafrost which in some cases, reaches 2,000 feet in thickness. Such water is saline.

Icings, created by a flow of water onto surface areas, form during the winter in river channels, on flood plains, and on alluvial fans. Icings are good evidence of the occurrence of ground water. Extensive icings occur where large perennial springs discharge into river valleys. Pingos, an example of icings, are conical, ice-cored hills formed by discharge of ground water under artesian pressure and are formed on the Arctic Coastal Plain and near Fairbanks on the Yukon-Tanana Upland.

Recharge of the principal alluvial ground-water reservoirs occurs largely through the frozen zones underlying streams. The most important source of ground water in the Tanana Basin is seepage from streams. Recharge to other aquifers is from precipitation.

The direction of movement of water in the alluvial flood-plain deposits of the river valleys is generally parallel to the direction of streamflow, whereas direction of movement in the adjacent terrace, alluvial fan, and upland deposits is, in general, parallel to the surface slope (topographic expression) of these land forms. The direction of water movement in confined zones within the alluvium or bedrock aquifers and within fracture of joint systems in bedrock is independent of surface features.

Discharge of ground water from principal alluvial aquifers occurs largely as base-flow discharge to streams. Ground water is also discharged at springs, lakes, and wetlands and directly by evapotranspiration from shallow ground-water reservoirs.

Water Withdrawals

Total water withdrawals in 1975 were estimated to be about 305 million gallons per day. Principal uses were for wood pulp production, fish hatcheries, and for domestic, commercial, and institutional needs. Figure 19-7 illustrates Alaska water withdrawals for 1975. Water withdrawals are anticipated to increase to 745 mgd by 2000. Figure 19-5 shows the expected withdrawals by major uses.

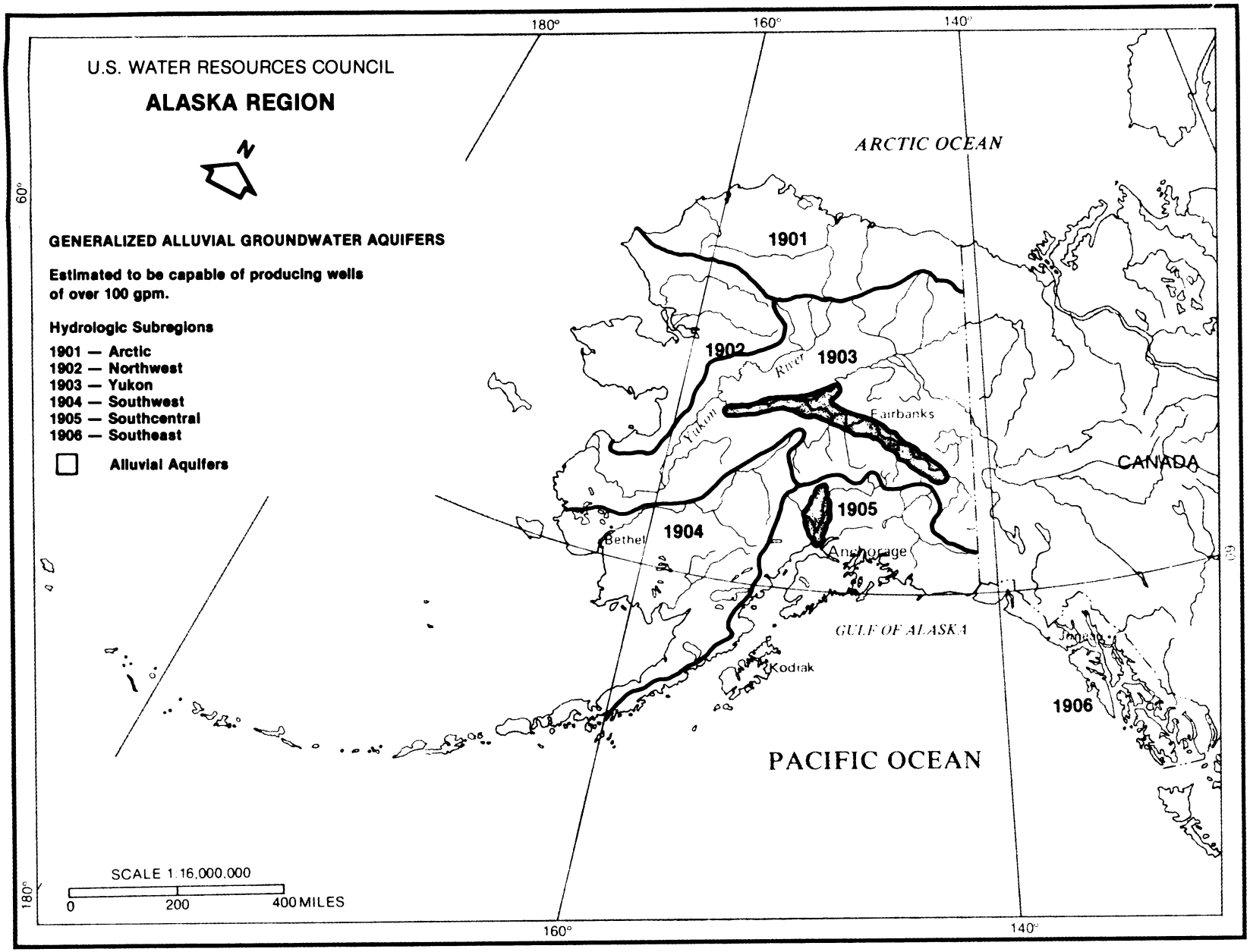
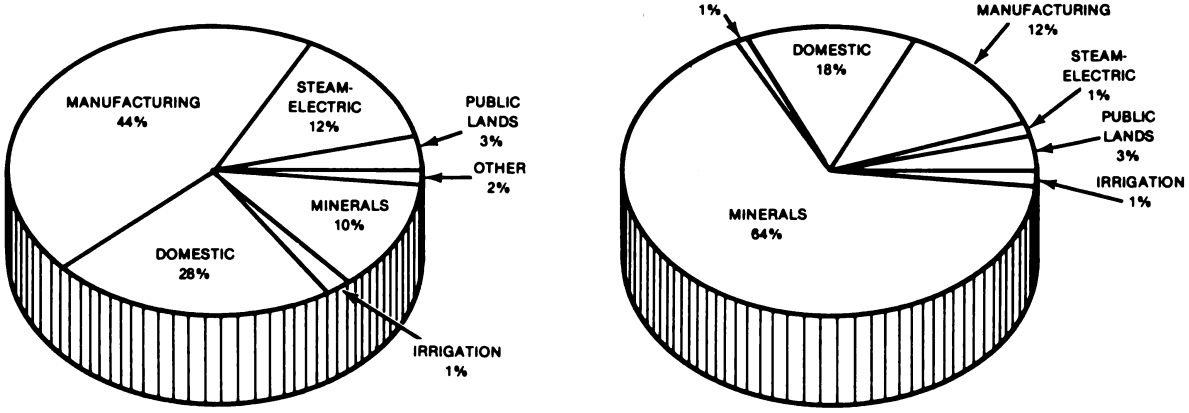


Figure 19-4. Major Aquifers

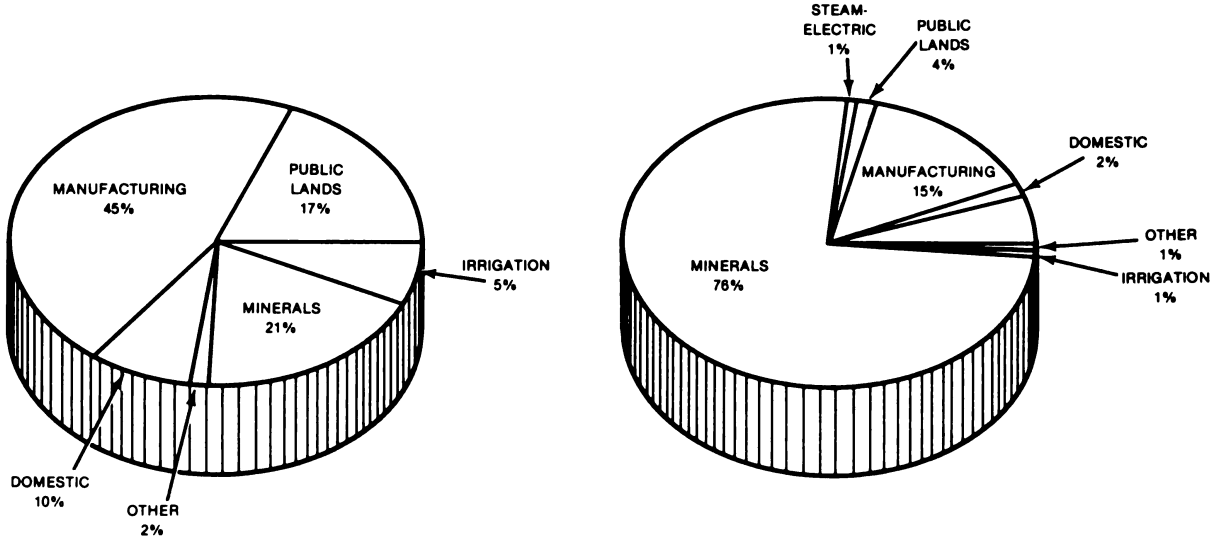
ANNUAL FRESHWATER WITHDRAWALS



1975
Total Withdrawals — 305 MGD

2000
Total Withdrawals — 745 MGD

ANNUAL FRESHWATER CONSUMPTION



1975
Total Consumption — 58 MGD

2000
Total Consumption — 459 MGD

Figure 19-5. Withdrawals and Consumption

Total withdrawals as projected by the NF are expected to increase over the next 25 years to 745 mgd. Mining is expected to increase phenomenally to 63 percent of total withdrawals, primarily due to fuel needs. Domestic, manufacturing, and steam electric uses are projected to make up 18,11, and 3 percent, respectively, of total withdrawals. SRF data show withdrawals in 1975 for fish hatcheries and much higher withdrawal rates in 2000 as discussed under comparative analysis.

Water Consumption

The region has not estimated water consumption. The NF estimated consumption for 1975 was 58 mgd, with 26 mgd consumed for manufacturing purposes. Domestic, mining, and irrigation uses make up 10, 21, and 5 percent, respectively, with the remainder for public land and other resources. Total consumption for 2000 is projected to be 459 mgd. The development of fuels increases the mining consumption to about 350 mgd, or about 76 percent of total consumption. Public lands, manufacturing, and domestic uses are projected to consume 4, 15, and 2 percent, respectively. Agriculture and commercial uses make up the remainder of consumptive use (Figure 19-5).

Instream Uses

Instream flow needs involve both quantity and quality of water for various uses such as fish and wildlife, recreation, hydroelectric power development, and navigation. Needs for these purposes have not been identified for most of Alaska. Data are urgently needed for water and related land resources planning and protection of Alaska's water resources, because as previously indicated, the State is undergoing rapid expansion in population and industry. This expansion is expected to continue for the balance of the century, though at a more uniform rate than that which has occurred in the past few years.

There are few legal requirements or agreements regarding the maintenance of instream flow needs in Alaskan waters. In 1871 the United States signed a treaty with Great Britain which provided for the maintenance of the Yukon, Porcupine, and Stikine Rivers. Article XXVI of that treaty states that navigation of these rivers ". . . shall forever remain free and open for the purposes of commerce to the subjects of Her Britannic Majesty, and to the citizens of the United States . . . ."

The Alaska constitution provides water priority rights to public water supplies and to fish and wildlife needs. Community water needs are recognized by Alaska statute, but provisions for instream flow needs for fish and wildlife have been only partially implemented.

Many of the waters of the State are high quality. However, some specific areas exhibit various water quality problems, and concerns have risen as a result of chemical and organic pollution, excessive withdrawals, sedimentation, and temperature changes. Untreated sewage is a problem in

many Alaskan villages. There is serious concern that industrial pollution from mineral, petroleum, and coal processing may cause substantial depletion of fish habitat, both in fresh-water spawning and marine waters.

Excessive withdrawals are a problem in Arctic areas where precipitation is slight and waters are frozen for much of the year. In addition, permafrost affects instream flows. Although State constitutional support exists for the protection of instream flow needs for fish and wildlife, regulatory action has yet to be taken to provide such protection. As growth in population and industry proceeds in Alaska and as competition for water resources increases, the need for regulatory protection under mandates of law becomes increasingly urgent.

Visitors to Alaska and residents using water and related land resources for recreational purposes expect the waters to be of high aesthetic quality. In several instances, satisfaction of this expectation may be an important aspect in the multiple use of the waters of Alaska. Maintenance of instream flows of acceptable quality is crucial to recreation use of Alaskan waters.

Recreation interest in State waters is quite extensive, but the instream requirements for the maintenance of recreation values have not been quantified for most areas.

The Yukon, Kuskokwim, and Tanana Rivers now constitute the major waterways for commercial inland navigation. Other rivers and streams such as Noatak, Kobuk, Nushagak, and Stikine receive limited commercial traffic. Many other streams of Alaska are navigable and support varying amounts of recreation boating, as well as both summer and winter transportation. In many cases these streams provide the primary access to remote areas. As rapid growth continues in Alaska, additional demands will be made on waterways for many uses. Flow requirements for navigation need to be determined before conflicting developments and uses cause important transportation facilities to be lost. Such loss could have especially severe effects on remote villages.

Alaska has substantial undeveloped hydropower potential. Several potential projects are under active consideration for near-future development. The proposed Upper Susitna River Basin Project would utilize the runoff from about 6,160 square miles with two major dams on the Susitna River. The first stage of the project could be completed as early as 1986. Several smaller potential hydropower sites are being considered by some of the coastal cities in southeast and southcentral Alaska. The building of dams may adversely affect the passage of migrating fish. The National Future (NF) fish and wildlife instream flow approximation for the total outflow from the region is 859,000 mgd.

Water Supply and Demand

As discussed earlier in this section, Alaska water supplies, when considered as a whole, are immense and will continue to exceed demands for the foreseeable future. However, it should be recognized that many specific areas of the State are experiencing intensive, growing use of available water supplies.

A multitude of demands are being placed on the water and related land resources of the Alaska Region. Water resource demands for various uses and functions are those pertaining to domestic use; fish and wildlife protection and enhancement; agricultural use including irrigation and livestock subsistence; mining of coal, metallic and other minerals, sand, and gravel; production of energy for various purposes, especially including, oil and natural gas; petrochemical plants; hydroelectric and steam electric operations; and food and fiber industries, such as fish and shellfish processing and pulp mills.

Demands are anticipated to triple by the year 2000. It is important that recognition be given to geological, cold-climate, and other limitations which make it difficult to obtain an adequate source of water for year-round use in some areas of the State.

Comparative Analysis

Table 19-5 compares the National Future (NF) and State-Regional Future (SRF) estimates of streamflows and water needs in the Alaska Region.

SRF estimates of total withdrawals are greater than the corresponding NF estimates for 1975, 1985, and 2000. No information about fish hatchery water withdrawals is available in the national data. On the other hand, State sources indicate fish hatchery withdrawals are comparable to those of domestic plus commercial use. If these significant fish hatchery withdrawals are excluded from the SRF total withdrawal figures, the SRF and NF totals become less discrepant for 1975. By the year 2000, remaining differences are accounted for largely by the SRF projected increases in agriculture, steam electric power generation, and manufacturing water uses. NF data indicate a decrease or no change in these functional use categories between 1975 and 2000.

Because no estimates of water consumption were developed by the SRF, no meaningful comparisons between SRF and NF consumptive use can be made.

Table 19-5.--Socioeconomic and volumetric data summary: the Alaska Region

Category	1975		1985		2000	
	NF	SRF	NF	SRF	NF	SRF
SOCIOECONOMIC DATA (1000)						
Total population	307	409	361	606	438	992
Total employment	135	186	164	267	205	426
VOLUMETRIC DATA (mgd)						
-Base conditions-						
Total streamflow	905,058	NE	905,058	NE	905,058	NE
Streamflow at outflow point(s)	905,000	816,000	904,851	NE	904,599	NE
Fresh-water withdrawals	305	345	433	711	745	1,243[a]
Agriculture	4	5	4	76	5	304
Steam electric	36	34	20	41	11	81
Manufacturing	134	88	93	125	86	149
Domestic	84	72	105	107	137	177
Commercial	7	[b]	9	[b]	10	[b]
Minerals	30	61	192	230	476	361
Public lands	10	NE	10	NE	20	NE
Fish hatcheries	0	85[c]	0	132[c]	0	171[c]
Other	0	0	0	0	0	0
Fresh-water consumption	58	NE	207	NE	459	NE
Agriculture	3	NE	3	NE	4	NE
Steam electric	0	NE	2	NE	5	NE
Manufacturing	26	NE	41	NE	68	NE
Domestic	6	NE	8	NE	10	NE
Commercial	1	NE	2	NE	2	NE
Minerals	12	NE	141	NE	350	NE
Public lands	10	NE	10	NE	20	NE
Fish hatcheries	0	NE	0	NE	0	NE
Other	0	NE	0	NE	0	NE
Ground-water withdrawals	44	NE	NE	NE	NE	NE
Evaporation	0	NE	0	NE	0	NE
Instream approximation						
Fish and wildlife	859,000	NE	859,000	NE	859,000	NE

NE - Not estimated.

[a] SRF considered two levels of development. Data are presented for high level development. Total withdrawals are estimated at 1,071 mgd for low level development.

[b] SRF domestic water use includes commercial and institutional requirements.

[c] SRF estimates based on average maximum water requirements (10 cubic feet per second or 6.5 mgd).

Problems

Alaska's future will bring increased demands and pressure on all resources and thus generate problems, especially with regard to water and related lands. In solving these problems, certain realities must be faced:

- Increasing demands by Alaska residents for both natural resource development and conservation.
- Broad national demands for energy, minerals, agricultural products, wilderness, and recreation resources in Alaska, all of which involve increasing pressures on the water resources.
- An extremely complex set of actions now underway which will radically change the ownership and management of the State's land and resources.

There is a need to develop experience relating to management of water and related land resources in cold regions--how to take advantage of cold region conditions subject to the limitations imposed by climate and other physical conditions. Throughout the period of the national assessment studies, there was a pervasive finding that not enough is known about Alaska's water and related land resources to do a good job of management, and that new data development is a high priority item.

Six issues were identified as having major statewide (regional) significance. These issues, which are discussed in this section, are remote village water, instream water, energy, water availability, flooding, and navigation, navigability, and ports. In addition, seven specific geographic area problems were identified that are considered to be of importance. These geographic problem areas are discussed in another section of this report.

Remote Village Water

Good quality water is extremely important to health. Seventy percent of Alaska's natives live in small, remote villages where safe water is seldom obtainable and adequate waste disposal is often impossible under present conditions.

Typical sources of drinking water are streams and ponds, many of which are stagnant and contaminated. Wells are frequently unproductive in areas underlain by permafrost. Rainwater is also a source of water supply. During the winter, villagers cut ice and melt it in discarded fuel drums. Per capita use ranges from 5 to 70 gallons per day.

Inadequate water supplies and waste disposal systems in many villages cause health problems and hardship. Some portion of village disease and death rates can certainly be attributed to substandard water supply and waste disposal methods. Village residents must devote a significant por-

tion of their time to satisfying basic sanitation needs. As a consequence less time and energy are available for more productive enterprises.

Water supply and waste disposal problems can be solved in most Alaskan villages given enough money and commitment by government. The technology exists to make adequate water supply and waste disposal services available in virtually all villages, but the technology can be applied only if money is available for capital construction. Such construction is merely a beginning; successful operation, maintenance, and management of village sanitation facilities are far more difficult to contend with than construction. Unless the problem of operation, maintenance, and management is solved, much capital construction effort could be wasted. New innovative financing, management, and training solutions are needed to successfully cope with village water and waste disposal problems.

Instream Water

Although the constitution of the State of Alaska recognizes general water reservations for fish and wildlife, there is a need for legislation to clarify the State's abilities and procedures to administer instream reservations. The problem is minimal now but is anticipated to become much more serious.

Fish, wildlife, recreation, hydroelectric power, and navigation functions provide the nucleus of instream water demands. Competing out-of-stream demands do not consider, or downplay, instream needs. Lack of methodology in analyzing and defining values among competing water resources functions and uses creates an imbalance. Actual allocation of instream flows can only be done on an objective basis through multiobjective water and related land-resources planning based on an adequate data base.

There is urgent need for a coordinated statewide basic hydrologic data gathering network as well as a methodology to evaluate instream flow needs. In addition, there is significant need for basic knowledge of the effect of out-of-stream use of water on the instream environment.

Integrated water quantity and quality considerations are very important. Excessive water withdrawals will create a water quality problem by reducing a stream's ability to handle pollution and cleanse itself. Excessive withdrawal degrades water quality by decreasing the volume of water--thereby increasing the pollutant load per unit. For example, sedimentation may degrade fish habitat, aesthetics, hydroelectric use, and navigation, as well as require artificial treatment and filtration for out-of-stream uses. Specific concerns regarding instream reservations apply to the following functions and uses:

- Fish and wildlife--providing sufficient flows of adequate quality for spawning, incubation, rearing, migration, and overwintering. Sufficient flows and fluctuation in flows to maintain the health of the stream habitat are necessary.

- Recreation--provide adequate flows of quality water for protection of the recreational, wild, scenic, and aesthetic nature of streams.

- Navigation--provide adequate instream flow to permit waterborne transportation of various kinds.

- Hydroelectric-provide adequate annual streamflows to permit hydroelectric development and operation.

- Water quality--provide adequate flows to maintain water quality. Avoid overallocation which will concentrate pollutant loads to undesirable levels.

- The ecosystems of estuaries at mouths of streams and rivers are dependent on fresh-water inflow.

Energy

Changing land status in Alaska will have an impact on energy development in the future. Much of the land chosen by the State under the Statehood Act and by the natives under the Alaska Native Claims Settlement Act may be available for development. Much of the remaining Federal land may be designated for single-purpose uses, such as parks and refuges, thus precluding energy development.

The potential degradation and disruption from offshore oil and gas exploration and development, major hydroelectric development, surface mining of coal, and energy transport facilities are of vital concern to those State and Federal agencies entrusted with the protection of the environment. Oil spills pose a particular threat as oil can destroy the food chains upon which the fish and wildlife depend. Although adequate laws and regulations exist to regulate the industry, the enforcement of the regulations concerns some people. Of particular concern to environmentalists is the production and transportation of oil on the Outer Continental Shelf.

Major impacts on land and water in recent years can be attributed to energy development. Not only are there water supply and quality concerns associated with energy development itself, but increased population around Fairbanks and Anchorage has caused some public water supply concern in those areas as well. In early 1976, some water users in the Prudhoe Bay area were temporarily ordered to cease withdrawals from the Sagavanirktok River on the North Slope when overwintering water pools were depleted below levels necessary for fish survival. On the Kenai Peninsula large ground-water withdrawals by petrochemical facilities, in combination with low rainfall, may be affecting local water table levels to the consternation of residential property owners.

In general, large quantities of liquid water do not exist on the North Slope during the winter months. The lack of water during cold months and poor quality of water supplies may limit the number of workers who can be brought into the area.

Secondary recovery at the Prudhoe Bay oil field will require large volumes of water, up to 11 million gallons per day, and given the arid nature of the area, sea water is the likely supply for this activity.

At this time marketability of Alaska's large coal resources is unclear. Transport could be by rail, slurry line, or barge. Some potential may exist for synthetic fuel industry using coal as a feedstock. Slurry line transport and synthetic fuel production would both require large amounts of water, but water availability in the coal region is not known.

Locations of support facilities for Outer Continental Shelf leasing may be limited by the availability of water at potential onshore sites along Cook Inlet, Gulf of Alaska, and North Slope.

Water Availability

Alaska is unique in that only a small portion of its water supply is appropriated. Potential projects for water use and development can still be planned, recognizing instream needs. In the mountainous and coastal regions of Alaska, water supplies are usually abundant. In the remainder of the State where semiarid conditions or extended cold periods exist, water shortages frequently occur. These large areas with low precipitation, predominantly frozen ground, extended seasonal freezing, and watersheds with relatively low water retention are characterized by drought or flood conditions with dramatic water fluctuations. In mountainous coastal regions, where precipitation may exceed 200 inches annually and water appears to be in perpetual abundance, only 20 or 30 days of cold weather will produce water shortages.

Water availability at specific sites depends on a broader spectrum of conditions than that normally necessary for prediction of availability in temperate climates. Hydrologic basin, region, subregion, subarea, site climate, and geology influence availability. Natural and manmade alterations at a specific site also appear to exert intensified effects upon availability.

Large rivers may flow throughout the year although low flow conditions occur in winter rather than in summer. Lesser streams, however, may flow in summer only. Myriads of lakes in the Arctic and interior valleys, deltas, and plains are generally shallow and remain frozen to the bottom much of the year. Tremendous amounts of water are accumulated in snowfields, glaciers, and permanently frozen ground. The cycle of availability of these sources, however, may be more closely related to hydrologic centuries rather than hydrologic years. Manmade and natural thermal influences have a great effect on the availability of these water supplies. The storage or flow of these waters is dependent upon those potential actions which determine water liberation.

Water availability is also dependent upon the quality of waters in each area. Some of the waters in the State are unavailable due to both natural and manmade pollution. Waters heavy in iron or organics are not normally suitable for use.

Flooding

Many areas in Alaska experience floods and property damage every year. It is a seasonal, natural phenomena that complicates man's permanent settlement and development of flood-prone areas.

Most of the floods are caused by:

- Stream overflow from snowmelt or rainstorms, or from outburst floods from glacier-dammed lakes.
- Water backed up from ice jams on rivers.
- Storm-driven waves causing coastal flooding.
- Aufeis (icings) plugging stream channels and causing overflow.
- Waves generated locally by phenomena such as massive rock or earth slides (either above or below water), ice falls and seismic induced seiche.
- Teleseismic tsunamis generated from earthquakes which come from the open sea as a series of waves.

Flooding is often accompanied by cold temperatures which tend to compound the associated problems.

There is a need to identify flood-prone lands. With good identification, future developments can be either guided to safe areas or, if impossible to do so, can be flood-proofed adequately to protect life and property. Although a significant number of flood studies have been made, additional studies are needed.

A comprehensive program of "planning with nature" is needed wherein future development--or redevelopment--will have the benefit of the identification of flood hazard in the planning stage.

Navigation, Navigability, and Ports

Alaska's waters not only provide a means of communication and commerce, but historically provided a significant part of the subsistence livelihood. Almost all of the communities have been built within easy access to either salt or fresh water.

Navigability determinations are important considerations with respect to land ownership issues and land settlements under ANSCA. If a watercourse or body of water is determined to be navigable in fact or susceptible to being used for commercial navigation at the time of statehood, then it meets the Federal test of navigability for title and the ownership of the submerged land rests with the State. In the case of private land that is adjacent to a stream or lake, the submerged land would be owned by the

State if it were navigable, or by the private owner if not. In terms of Native Land Selections, it is important to know if submerged lands will be owned by the State or the riparian land owner.

Because of the wide variety of climate, many of Alaska's rivers and ports are available on a limited basis, but when they are open, they bustle with commercial activity. Conversely the harbors of the Gulf of Alaska and the southeast enjoy year-round, ice-free operation. A shallow frozen stream will often enhance traffic to a remote community with the new snow vehicles that are available.

The waters of Alaska support a rich and growing fishing industry requiring an ever increasing number of vessels for harvesting and processing. These vessels in turn require ports, harbors, maintenance facilities, and well-marked and lighted passages to and from the fishing grounds. Southeast Alaska with its high mountains and deep fjords must rely upon the Marine Highway (a ferry system) for much of its commerce.

Recreational boating provides access to many roadless areas and opens these areas for land-based recreational activities. Again, these activities require harbors, maintenance facilities, and well-marked channels to assure safe passage.

As population increases and development occurs, additional demands will be placed on all waterways for both commercial and recreational usage. Several areas now accessible to the major communities are overcrowded, and recreation opportunities are seriously limited.

Individual Problem Areas

During the initial stage of the assessment, 16 "Water and Related Land Problem Areas" were identified in the State of Alaska. Figure 19-6a indicates the locations of the 16 areas. Problem issues are listed in Figure Figure 19-6b. Included in figures 19-6a and 19-6b are seven problem areas areas of additional significance as recognized by the Alaska Water Study Committee (AWSC). These include the Arctic, Tanana, Bristol Bay, Kodiak-Shelikof, Cook Inlet, Gulf of Alaska, and Southeast.

Criteria used to identify the significant problem areas included consideration of the following:

lack of domestic water
competition for water
land-use conflicts
property loss
safety
health
livelihood
erosion and sedimentation
resource use conflicts
disturbance of ecosystems and hydrologic subregions.

Three of the seven problem areas, the Kodiak-Shelikof, Cook Inlet, and Gulf of Alaska, are now under active Level B study, while the four remaining areas appear to be appropriate for early consideration by the Alaska Water Study Committee as candidates for special Level B, or other studies. Following is a discussion of seven significant problem areas in the Alaska Region. Included is a map, description, estimates of 1975 population, and a summary of problems identified for each area.

Arctic Area

Area: 81,000 square miles Estimated Population: 6,500

Climate: Arctic.
Average July temperature: Low 30's to low 50's.
Average January temperature: -20's to -5.
Annual precipitation: 5 to 19 inches.

Principal Resources: Oil and gas, coal, sea mammals, and wildlife.

Major Sectors of the Economy: Oil and gas, construction, government, services, and subsistence living.

The southern border of the Arctic area is located in the northern terminus of the Pacific Rocky Mountain system--the Brooks Range. To the north, the land becomes gently rolling foothills which flatten into the broad, treeless, tundra-covered coastal plains. The entire area is underlain by permafrost, and plant life consists of high brush at higher

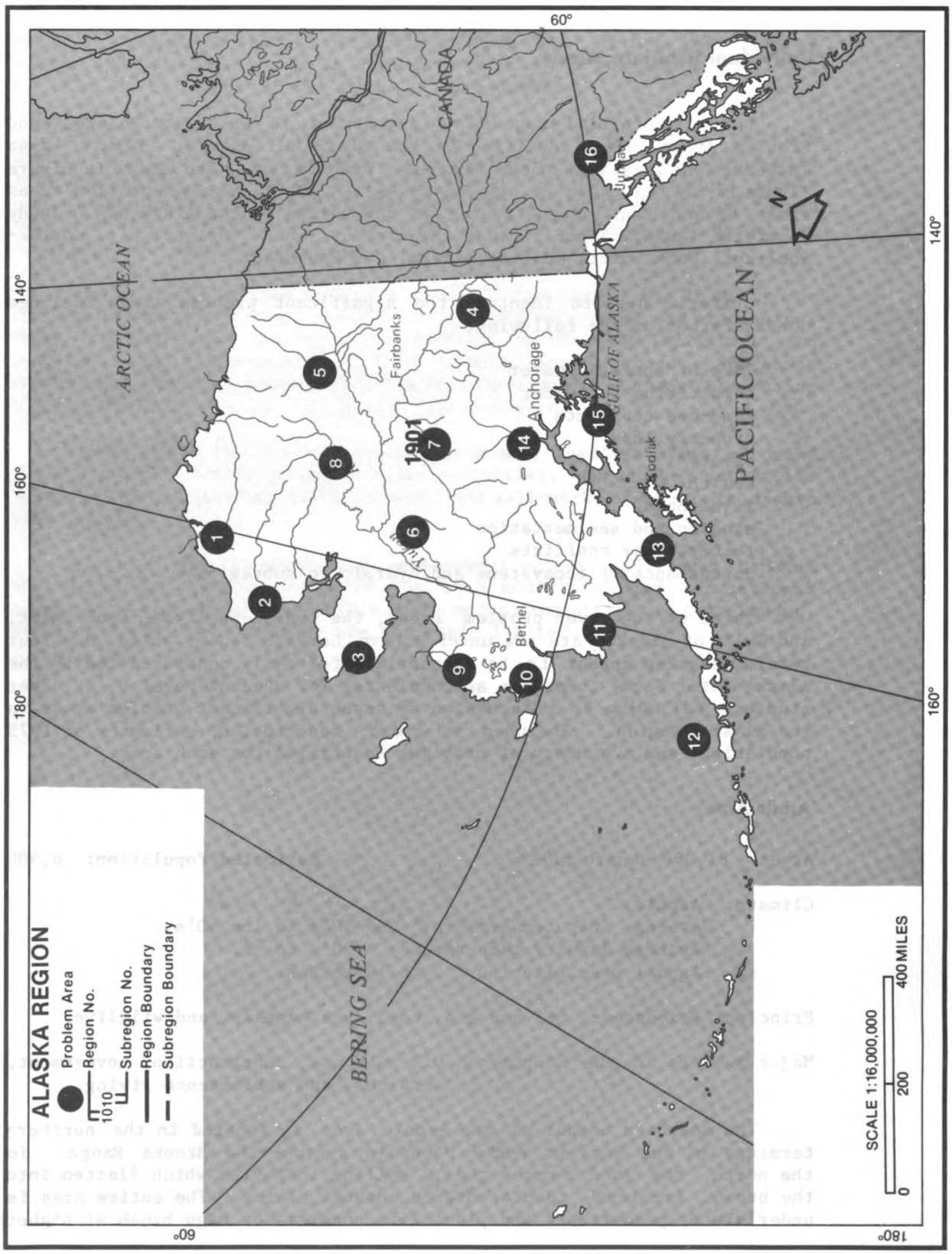


Figure 19-6a. Problem Map

ALASKA REGION (19)

PROBLEM MATRIX

Problem area		Problem issues: O Identified by Federal Agency Representatives; X Identified by State Regional Representatives												
		Water quantity				Water quality				Related lands				
No. on map	Name	Fresh surface	Ground	Marine and estuarine	Surface depth	Fresh surface	Ground	Marine and estuarine	Surface depth	Flooding	Drainage	Erosion and sedimentation	Dredge and fill	Water related use conflicts	Other
Subregion 1901	Alaska	O	O			O	O			O					O
Area 1	Arctic	X			X	X				X		X		X	X
2	Kotzebue Sound	X		X		X	X	X		X		X			
3	Norten Sound	X	X			X	X	X		X		X		X	
4	Upper Yukon – Canada											X			
5	Upper Yukon		X							X		X		X	X
6	Central Yukon	X	X			X	X			X		X		X	X
7	Tanana	X	X			X	X			X		X	X	X	X
8	Koyukuk	X	X			X	X					X		X	
9	Lower Yukon	X	X			X	X			X		X			X
10	Kuskokwim Bay	X	X			X	X	X		X			X		X
11	Bristol Bay	X	X	X	X	X	X	X						X	
12	Aleutian														
13	Kodiak-Shelikof	X	X			X	X	X		X		X	X	X	X
14	Cook Inlet	X	X			X		X		X	X	X	X	X	X
15	Gulf of Alaska	X	X			X	X	X		X		X	X	X	X
16	Southeast	X			X	X		X		X	X	X	X		

Figure 19-6b. Problem Matrix

elevations and various types of tundra. The area supports large caribou herds and over 150 species of birds. Coastal areas support populations of seal, walrus, whale, and polar bear, as well as fish which are unusually small because of the inhibiting influence of cold on both the fish and their food source.

The economy of this sparsely populated area is a combination of monetary, barter, and subsistence factors. The harvesting of fish and wildlife remains extremely important to most of the inhabitants. Government is a major element in the economy, and with the North Slope oil discovery and construction of the trans-Alaska pipeline, the oil industry has become the largest industry in the private sector. It is expected that growth in the area's economy will be based on continued exploration for and production of oil and gas.

Conclusions

The primary problems encountered in this area include:

Flooding

Flooding is an annual hazard along stream channels in the low coastal plain and along the Arctic and Chukchi seacoasts. The principal flood-prone rivers are the Sagavanirktok, Colville, and Mead. Extensive flood damage has been reported in Deadhorse and Anaktuvuk Pass. Wetlands and lagoons are vulnerable to pollution by sediment from construction to flooding by impeded drainages caused by roads and oil rig site construction. The formation of aufeis on rivers and in other drainage routes affects transportation and is a potential source of damage to public lands. Coastal flooding is a threat to the security of shipping facilities. Areas affected are Wainwright, Barrow, Lisbourne, Barter Island, and Point Lay. The periodically severe flood threat can hamper resource development.

Limited Fresh-Water Supply

Natural fresh-water supply in the Arctic is limited in winter to deeper surface ponds, and to a very limited number of thaw bulbs in gravel deposits under or adjacent to streams. Limited water supplies may restrict oil and gas exploration and production in the Prudhoe Bay, Beaufort Sea, and National Petroleum Reserve-Alaska areas. The increased use of surface water for petroleum production support will reduce supplies for fresh-water fish production, resulting in habitat decline and reduced supply for subsistence.

Surface-water quality will decline near population centers as water demands increase. Treating Arctic waste waters by standard practices is infeasible, and the abnormal problems may lead to pollution of streams and ponds. Fish populations near communities will be affected by declining water levels and toxic substances in their habitat.

Soil Erosion

Potential surface soil erosion following natural or manmade disturbance is high. Permafrost melting (thermal degradation) is followed by sinkhole formation and soil loss to running water and subsequent deposits in streams.

Coastal erosion is severe at certain exposed sites along the Arctic Ocean and Chukchi Sea. Point Hope village is presently in danger.

Roads, pipelines, and industrial community development on the Arctic Slope and coast must be regulated by stipulations such as those governing pipeline construction. These activities, with possible degradation of lagoons and wetlands, are hazards to large and important migrating populations of shorebirds and waterfowl.

Tanana Area

Area: 45,000 square miles Estimated Population: 62,400

Climate: Continental.
Average July temperature: Mid 40's to upper 70's.
Average January temperature: -10 to upper 20's.
Annual precipitation: Moderate to low.

Principal Resources: Fish and wildlife, timber, coal, and minerals.

Major Sectors of the Economy: Government, military, and University of Alaska.

The Tanana area is bounded on the south by the northern flanks of the Alaska Range and includes the lands drained by the Tanana River. This area also includes Mount McKinley National Park. The interior is primarily a broad plateau of rolling hills, periodically intersected by mountains. Forests of birch and spruce cover much of the lands along the river valleys, and the land supports abundant wildlife. Discontinuous permafrost is present throughout the area.

The city of Fairbanks is the largest city in the area, and there are numerous small villages scattered throughout. Many of the people, both native and nonnative, are dependent on a subsistence economy.

Government is a major component of the economy. The main campus of the University of Alaska was established at College near Fairbanks and has made significant contributions to the economy.

Fairbanks and the surrounding areas have experienced rapid growth since construction began on the trans-Alaska pipeline. Continued growth is expected for the balance of the century with expansion of industry, forestry, and agriculture.

Conclusions

The problems of this area were found to be those pertaining to:

Water Quality

Water supplies for communities, industries, or agriculture need enlargement, improvement in quality, and, in some cases, protection from contamination or restrictions for instream flows.

With recent growth, Fairbanks needs enlargement of water supply, waste-water treatment, and distribution systems. Some ground waters in the vicinity of Fairbanks are contaminated with arsenic (a serious health hazard) or with sewage effluent. The Healy Reservoir and Tok ground-water supplies are subject to contamination by flooding. Withdrawal of irrigation waters at Big Delta (and potentially at other sites) may impair instream flows.

Sewage and solid waste disposal systems in the area need particular attention. Sewage contamination from individual homes is a potential or existing problem in Nenana, Fairbanks, Healy, and Tok. Solid waste disposal methods are inadequate areawide, and commonly contaminate surface and ground waters.

Potential for serious water pollution problems exists with regard to agricultural and oil industry chemicals or contaminants. Erosion and sedimentation of silt soils, degrading quality of waters and stream habitat, can easily result from poor road building, logging, and agriculture practices. Cropped-soil wind erosion also occurs near the Delta River.

Haphazard urban development in and near communities leads to degraded water quality, to costly water and sewer utilities, to flood hazards, to lowering of the water table (Tok), and to other water related problems.

Water Supply

Suburban areas of Fairbanks suffer from marginal to inadequate water supply facilities. Recharge to ground-water reservoirs is probably almost nonexistent in the upland areas. Similar water supply problems are probable in most of the area around Fairbanks.

Flooding

Flood-prone and flood areas are not adequately identified, and guidelines for development in flood hazard areas are poorly defined. Flood mitigation may be possible in some instances, i.e., aufeis flooding at Delta Junction.

Instream Use

Protection for instream flows for fish and wildlife habitat is needed for streams of the area. This is true in the vicinity of Big Delta, and is also reportedly true for the Chatanika River.

Ice Fog

Ice Fog develops from power, heating, and transportation systems in the Fairbanks-North Pole communities.

Bristol Bay Area

Area: 40,000 square miles Estimated Population: 5,950

Climate: Maritime and transitional.
Average July temperature: Upper 30's to upper 60's.
Average January temperature: 0 to upper 20's.
Annual precipitation: 15 to 36 inches.

Principal Resources: Fish and wildlife, including sea mammals, minerals, and oil and gas.

Major Sectors of the Economy: Commercial fishing and processing, government, and recreation.

This area is bounded on the south by the Aleutian Range and encompasses the lands draining into Bristol Bay. Hills rise from a few hundred feet to over 2,000 feet above the marshy, lake-dotted coastal plain.

The Bristol Bay estuary with its tributary waters is the world's most productive red salmon fishery. The area also produces large quantities of bottomfish and shellfish. Bristol Bay also provides habitat for almost the entire population of Pacific black brant, most of the world's emperor geese, hundreds of thousands of ducks, geese, swans, and millions of shorebirds.

In addition, Bristol Bay receives income from tourism, trophy fishermen, and hunters. Some of the larger trophy moose and bear are found in the area.

Recent explorations indicate potential for oil deposits in Bristol Bay, and the Bristol Bay Native Association has leased land for oil exploration. To protect the fishery, the Alaska Legislature identified areas of the eastern waters of the Bay from which oil activity is excluded. Economic growth is anticipated for all major sectors of the economy.

Conclusions

The problems identified in the Bristol Bay area pertain to:

Water Quality

Community water and sewer facilities are lacking for the majority of Bristol Bay residences. Fish processers are also short of water of adequate quality during some seasons.

Oil exploration and development in or near Bristol Bay will place demands on the area's water resources, while imposing threats to fresh and salt-water habitats and to valuable wetlands. Development by the oil industry of water resources could assist communities in their efforts to improve water facilities.

Bristol Bay lacks year-round transportation systems to support local and export commerce. Introduction of more roads, improved and increased sea transportation, and oil pipelines from or through the area will alter the uses and values of fresh and estuarine waters and present a continuing hazard to the habitats of many species of fish and wildlife.

Large-scale mining of metals (iron of Kemuk Mountain near Dillingham, copper and related metals in the vicinity of Lakes Clark-Iliamna) is feasible in the future, but it has the potential for water quality degradation.

Energy

Communities need better electrical alternatives than diesel power. Hydropower, natural gas-fired turbine generators, and geothermal generator units have been well-evaluated for this area.

Hydropower reserves have been identified for about 10 watersheds but several of these, for example, Lake Iliamna and Naknek Lake, are highly unlikely prospects for any power development. Such reserves can hinder other uses of the water, lakeshore, and adjacent lands.

Water Use

Access and easements to water margins and salt-water shores of native corporation-owned lands may remain a problem for many years, particularly with regard to public access for subsistence, fishing-hunting, and recreational uses.

Navigation

Improvements in harbor and navigational facilities are needed. A public dock is needed at Naknek. Dillingham's small boat harbor is inadequate and a solution or alternative is needed. Aids to navigation, particularly between Dillingham and Togiak, need improvements and additions.

Kodiak-Shelikof Area

Area: 11,000 square miles Estimated Population: 9,300

Climate: Maritime.
Average July temperature: Low 40's to low 60's.
Average January temperature: Low 20's to mid 40's.
Annual precipitation: 20 to 60 inches.

Principal Resources: Fish and wildlife, incuding shellfish and sea mammals, timber, and potential for minerals.

Major Sectors of the Economy: Fishing and seafood processing, government, tourism, trade, and service industries.

Located in southcentral Alaska, the Kodiak-Shelikof area covers 11,000 square miles of steep, rugged terrain, is extensively glaciated, and includes the mountainous southern coast of the Alaska Peninsula and the Kodiak Island group. Volcanic activity and frequent earthquakes are characteristic of the area. The coastline of the Kodiak Island group is very irregular with many deep fjords and islands.

Historically, fishing and seafood processing have been the economic mainstay of this area and accounted for more than 30 percent of total employment in 1972. Major species include salmon, halibut, shrimp, and king, tanner, and Dungeness crab. With a population of less than 4,000, the city of Kodiak is the commercial center for the problem area. Growth is anticipated for all major segments of the economy. There is also potential for oil and gas development.

Conclusions

The State expects growth in the economy, population, and water uses of the Kodiak-Shelikof region. The native village corporation's acquisition of land may stimulate developments. Expected petrochemical activities associated with the lower Cook Inlet and Kodiak Outer Continental Shelf oil leasing will require increased support from the Kodiak Community. Increased activities by both the fishing industry and the Coast Guard may result from implementation of the 200-mile fisheries limitations.

Problems identified in the area pertain to:

Water Use

There are potential water-use conflicts between placer mining interests and fisheries, between wildlife and domestic red meat production, and between recreation users and commercial fishermen.

Ports

Adequate marine facilities are needed including scheduled service, boat moorage, port, and harbor facilities.

Water Availability

Adequate water supplies are needed for the communities of Kodiak, Karluk, Larson Bay, and Old Harbor. Water withdrawals are, in some instances, reducing quantity and quality of instream water for fish, waterfowl, and wildlife habitat. Data are needed on water availability, especially data on ground-water aquifers.

Water Quality

Adequate sanitary and garbage facilities at public use areas should be provided and maintained.

There is great potential for degradation of fresh- and salt-water fisheries near and accessible to population centers and concentrated land uses. Secondary waste-water treatment discharges to the sea may be harmful. Erosion and sediment production may be caused by livestock trampling concentration and overuse of range.

Instream Use

Instream flow needs for fish and wildlife need to be provided for.

Flooding

Flood hazards--coastal flooding and erosion threats at Chignik, Karluk, Larsen Bay, Old Harbor, Ouizinkie, Perryville, and Port Lions--need to be minimized.

Cook Inlet Area

Area: 38,000 square miles Estimated Population: 211,000

Climate: Maritime and transitional.
Average July temperature: Mid 30's to upper 60's;
Average January temperature: -10 to 40's.
Annual precipitation: 20 inches.

Principal Resources: Fish and wildlife, timber, oil and gas, coal, and scenery.

Major Sectors of the Economy: Government, military, service industries, oil and gas, fish, tourism, and transportation.

The Cook Inlet problem area lies in the southcentral subregion of Alaska. Extending from the crest of the Alaska Peninsula on the west and the Alaska Range on the north, the Cook Inlet area covers an area of 38,000 square miles. The land here is characterized by extensive glacier

systems, considerable tectonic and volcanic activity, an extensive coastline with prolific sea life, and fairly extensive wilderness areas which support abundant wildlife.

Approximately 41 percent of the State's population resides in the Cook Inlet subregion. Since World War II the city of Anchorage has become the State's center of commerce and economic activity. Anchorage has become the headquarters for the oil and gas industry, and, largely because of pipeline activity, has experienced rapid growth. Continued growth is expected at least for the balance of the 70's. Fishing and logging are also significant elements in the economy.

Conclusions

Problems identified include those pertaining to:

Water Availability/Quality

There is a need to expand water supply and waste-disposal facilities and to provide new facilities. Communities on the Kenai Peninsula are in particular need of satisfactory water supplies.

There is urban encroachment on wetlands, farmlands, flood plains, and municipal watershed lands. Those areas in the lower Susitna-Matanuska Valleys are particularly susceptible. Riverbanks and stream-side quality have been seriously damaged on the Kenai River. There are heavy pressures on and overcrowding of water-based recreational facilities and increased competition in recreational harvests of fish and wildlife resources. This is particularly true for waters accessible by road.

Heavy water uses associated with urbanization, and in some cases with agriculture, are changing the natural hydrologic system. Instream flows are reduced, lake levels lowered, and native vegetation altered. Additional developments in the capital site area, as well as other areas, will further alter the natural system.

Land-waste management and injection of waste through wells have further degraded the quality of water in the area. Continued placement of waste without regard to hydrological flow systems will rapidly degrade water quality in large areas.

Energy

Water resource concerns are associated with proposals for major new oil and gas, coal, and hydropower developments. Oil and gas development in lower Cook Inlet is located in or near important fishing grounds. If Beluga coal is developed for export it may affect fresh-water habitats for fish and waterfowl.

Removal of coal by strip mining may result in serious degradation of ground water. This, in turn, would also affect surface-water sources.

Institutional

Significant changes in land use, ownership, and management will result from the Alaska Native Claim Settlement Act. Ownership of rivers, river-banks, lake beds, and certain areas of the coastal zone will be increasingly disputed, along with allocation of water rights.

Ports

Existing Kenai Peninsula port and harbor facilities within Cook Inlet will require expansion to support projected growth.

Water Use

Growth in agricultural activity will need provision for water and water-related management and planning. Such plans should deal with water withdrawals for irrigation, controls on uses of water-polluting chemicals, and practices to minimize sediment production.

Gulf of Alaska Area

Area: 34,000 square miles Estimated Population: 11,600

Climate: Maritime and transitional.
Average July temperature: Low 40's to low 70's.
Average January temperature: Low 20's to mid 40's.
Annual precipitation: 10 to 180 inches.

Principal Resources: Fish and wildlife, including shellfish and sea mammals, timber, minerals, and oil and gas.

Major Sectors of the Economy: Oil, fishing, seafood processing, government, and trade.

This area lies in southcentral Alaska and lies east of the Cook Inlet area. Principal physiographic areas include parts of the Alaska Range draining into the Gulf of Alaska, an intermontane basin formed by Gulkana upland and the Copper River lowland, the Wrangell Mountains, Kenai-Cugach Mountains, Prince William Sound, and the Gulf of Alaska coastal section.

This is the most economically underdeveloped area in southcentral Alaska. Unemployment prior to pipeline construction was consistently high, and historically State and local governments have been the major employers in the area's economy. Most of the area's population reside in the coastal towns of Cordova, Valdez, Seward, and Whittier.

Construction of the trans-Alaska oil pipeline has had a significant effect on this problem area. The pipeline terminal is located at Valdez, and for about a 2-year period a large number of new jobs were added to the economy with a concomitant increase in the area's population. Continued growth in population and all major segments of the economy is anticipated for this area.

Conclusions

The population of this region grew rapidly with construction of the Alaska oil pipeline, pump station, and terminal facilities. The State expects continued growth as a result of petroleum transport activity, supplemented by exploration for oil and gas in the Gulf of Alaska. Additional elements of growth will come from expected development activities on native village and corporation lands.

Problems identified here include those pertaining to:

Water Availability

There is a shortage of water for municipalities (Valdez), for fish processing (Cordova), for placer mining, for livestock (Kenney Lake), and for maintaining minimum flows (Chistochina and Nizina areas).

Data on location and quantity of potable ground-water aquifers and of water supply (including snow pack) is lacking as well as data on areas of flood hazard, erosion, and sedimentation hazard.

Water Quality

Problems exist with respect to surface water with heavy sediment loads. Flood hazards (the Bering River, Valdez River, and tributaries of the Copper River), saline ground water (interior area), and potential pollution from marine traffic and offshore oil production are also problems.

Urban areas are encroaching upon wetlands, farmlands, flood plains, sensitive geologic and biological areas, and municipal watershed lands. Solid and liquid waste disposal systems are inadequate. Public areas are overused (Gulkana River) and public facilities are lacking.

There is the potential threat of degradation of water quality from placer mining, sand and gravel extraction, forestry, agricultural land use, drilling rigs, and mine-processing plants.

Water Use

There are resource use conflicts between fisheries and oil development and production, between recreational fishing and commercial fishing, and between logging and fisheries-hunting-recreation values.

Southeast Area

Area: 42,000 square miles Estimated Population: 50,900

Climate: Maritime.
Average July temperature: Low 40's to high 60's.
Average January temperature: Low 20's to low 40's.
Annual precipitation: 20 to 220 inches.

Principal Resources: Fish and wildlife, including shellfish and sea mammals, timber, and minerals.

Major Sectors of the Economy: Government, forest products, fishing, and tourism.

The Southeast Area stretches nearly 600 miles along the border of British Columbia from Cape Dixon in the south to Icy Bay in the north. The Coastal Mountains, rising sharply from the water's edge, form the mainland and the 1,100 islands of the Alexander Archipelago. This is a scenic area of fjords and steep-walled valleys, of slow-moving glaciers and barren icefields, of high mountain lakes, streams, and waterfalls. Abundant fish and wildlife are found here.

This area contains about 14 percent of the State's population and has several of the State's centers of population, as well as many small villages. Community development is often limited by steep terrain. Roads are few, and the Alaska Marine Highway System and air transportation provide access to and within the area.

Government--Federal, State, and local--is the major employer in the Southeast. Next to government, timber-based industry is the economic mainstay of the area. Fishing is next in economic importance, although catches have declined in recent years. Tourism and recreation are also major components of the economy. Many inhabitants of small towns and villages enjoy a subsistence livelihood. Moderate economic growth is anticipated for this area.

Conclusions

The major problems found in this area include those pertaining to:

Water Availability

The number of domestic and industrial water users are increasing, placing a strain on the poor distribution systems and inadequate volume of water storage facilities. Very little cheap water storage is available due to the terrain.

Ground-water resources are poorly identified; many surface streams have inadequate flow during extended rainless periods.

The need to solve winter freeze-ups and summer drought water supply problems will become more severe in most communities.

Water Quality

Water quality degradation has been and remains a problem. The forest products industry has produced instances of sediment, chemical (pulp mill effluent), and thermal pollution. Sediment, chemical, and thermal pollution from point sources could occur from future mining in southeast Alaska. Seafood processers and communities have, in the past, dumped their wastes into salt waters. Such pollution is reduced now, although it has not always been possible to work out effective alternatives.

Energy

Southeast Alaska currently uses a large percentage of the hydropower produced in the State. Very little of the State's energy potential has been developed. Most potential projects are seen as costly to develop, small in size, and located at some distance from the users, thereby requiring costly transmission lines.

Water Use

Pending State and native land selections and resultant uses will change the use and care of the area's related water resources. This is true for lands that may be developed for timber, mineral, or tourist values.

Competitive demands of timber, fishing, mining, recreation-tourism industries, and of growing communities themselves produce conflicts over management of related water resources.

Adverse Effects

Water problems found in the Alaska Region are complex and interrelated, and the implications and adverse effects of not solving these problems are far-reaching both from a regional perspective and from the national viewpoint. Development of the significant energy resources, fishing industry, and wood and paper products industry could be critically curtailed and could have a major impact on both the State and the Nation. Water resource problems in Alaska will become increasingly severe as the State's population continues its rapid increase and as local and national pressures for the development of Alaska's resources continue to build.

Major energy developments are expected in the near future in Alaska; however, the inadequacy of surface water and lack of data on ground water may inhibit energy development, thus hindering efforts towards national energy self-sufficiency and limiting population and economic growth in energy-rich areas. There is great potential for environmental damage if development takes place without adequate safeguards for protection of fish and wildlife and without adequate measures to minimize the risks of petrochemical pollution.

If provisions are not made for the protection of instream flow needs and riparian habitat for fish and wildlife, public water supplies, hydroelectric developments, navigation, and recreation needs, the increased competition for water--especially in areas where shortages already exist--may cause irreparable damage and irreversible situations. If the recommended studies are not initiated soon and if measures are not taken to protect fish and wildlife needs, permanent loss of habitat may result with consequent loss to the fishing industry, to subsistence hunters and fishermen, to recreation values, and to national conservation concerns on the whole.

Institutional issues involving water resources include overlapping and duplication of work among government agencies as well as conflicts among various agencies. Better coordination and active partnership among State and Federal agencies would allow better management of Alaskan resources and would probably reduce the costs of management. Another problem involves the absence of institutions designed to deal with issues peculiar to Alaska. Large parts of Alaska are in the unorganized borough status. In effect, there is no local government for these areas, and the State Legislature constitutes the only government. Thus there is no structure to enforce flood-plain controls, human waste disposal, or to provide services such as central water supply and waste treatment.

Data on Alaska's hydrology is very sketchy except in the more populated areas. In order to ensure that the Nation receives the benefits of resource development in Alaska, while utilizing and protecting the State's uniquely rich environmental resources, detailed studies of the water and related lands will be necessary. If such research is not done before further developments proceeds, irreparable harm to the environment, as well as delays and increased costs for industry, may result. The

siting of developments which use large quantities of water where such supplies are available can only be accomplished if sufficient information is at hand. The implications of not having adequate information and data prior to development are alarming to responsible Alaskans. The potential for mismanagement is immense both in terms of industrial and environmental costs. Such actions could result in lengthy delays in processing and supplying much-needed resources, such as oil and coal, to the Nation.

A uniquely Alaskan water problem involves water supplies and sewage treatment facilities in Alaska's remote villages. The public water supply in many villages consists of periodic ice collections in the winter. In permafrost areas ground water may be absent or very hard to obtain. Nearly half of remote village populations need immediate improvements in their water supply. Sewage disposal is a severe problem in most villages. The technology for solving these problems is available; however, costs are high. Not only do facilities need to be constructed, but often villages are unable to pay for operation and maintenance of the facilities. In addition, most villages are unable to provide trained personnel to run the facilities. If this problem remains unsolved, the standard of life will remain at a low level, associated health problems will be intensified, and opportunities for growth and development will be limited.

Summary

Tremendous changes are currently taking place in Alaska. The population continues to grow rapidly. The frontier economy of a few years ago is rapidly becoming much more diversified. Expansion in the energy and mineral industries has made the principal contribution to this growth with construction of the trans-Alaska pipeline playing a major role. The Alaska Native Claims Settlement Act of 1971 has brought about unprecedented changes in the ownership and management of Alaskan lands.

Alaska's population of 307,000 (NF estimate) remains relatively young and is primarily urban. The 1970 census shows a median age of 22.9 years with 39.9 percent of the population under 18 years of age. Over half of the State's population lives in the Railbelt area, which includes the State's two largest cities of Anchorage and Fairbanks. Twelve percent of the population resides in the cities of southeast Alaska. Most of the remainder live in remote towns and villages scattered across the State. The male/female ratio, traditionally weighted toward males in frontier settings, is leveling off. There are now about 119 males for every 100 females. Since the 1970 census, Alaska's population has increased about 30 percent, and most of the increase has occurred in the last 2 years primarily because of growth induced by pipeline construction.

Energy

Alaska's energy resources are receiving more attention now than at any time in the past. Construction is complete on the trans-Alaska crude oil pipeline, and proposals are well underway for pipelines to bring the North Slope natural gas reserves to market. Both the State and Federal Governments have offshore leasing programs, with several areas targeted for early lease sales. Several of the native corporations have exploration programs.

Several other major energy development proposals are under active consideration, including coal and hydroelectric development. Major new coal mining seems probable during the period of this study, with current interests focusing on strip-mining proposals in Cook Inlet. Current hydroelectric proposals include a major development of the upper Susitna River and several smaller projects that would serve isolated coastal cities.

The rapid pursuit of oil development involves a full measure of controversy: concerns over pollution and the growth induced by the development, impact on quality of life, critical estuarine areas, and so forth.

Water implications include the need for assuring adequate pollution control measures and for protecting critical environmental resources, as well as water supplies for energy development.

The relative unavailability of water in large parts of the State may impose limits on, and in some cases determine, the types of energy development that may occur. Coal mines, refineries, and petrochemical plants involve very significant water requirements.

Commercial Fisheries

These have long been an important sector of the economy and a major source of employment. From the viewpoint of the water assessment, anadromous fish species, especially salmon, are most important. There is a very strong desire to preserve fresh-water habitat which is of value in salmon production. At the same time, many people believe that the State will rely heavily in the future on various intensive management practices to produce the fish. Some estimates indicate a possible three- to four-fold increase in salmon production through aquaculture. Expansion is assumed in the fisheries industry.

Forest Products

Forest products constitute another very important resource which is mostly based on the coastal forests of southeast Alaska and the eastern Gulf of Alaska. The interior forests are generally much less productive, but do also offer some commercial opportunities. Modest expansion of the forest products industry is anticipated. There are potentially serious water-use conflicts between the forest and fishery interests.

Agriculture

Agriculture remains a small component of the Alaska economy, and at present economic factors do not generally favor rapid expansion of this industry. The State's agricultural community considers farming and livestock range production to be a major regional potential and projects significant expansion of agriculture by the year 2000.

Other Mineral Resources

Other than fuels, production of construction materials, and some fairly intensive exploration programs, the minerals industry is at present a fairly small sector of the Alaska economy. Known resources include iron, molybdenum, copper, and nickel deposits of major significance. There is strong likelihood that the State will become a major producer of metals by the year 2000.

Tourism

This has been a rapidly growing sector of the Alaska economy, and substantial additional growth is anticipated. Alaska offers unique and varied experiences to the tourist. Scenery is of exceptional beauty from the snow-capped mountains of southeast Alaska to the flower-carpeted tundra of the Arctic in summer. The abundant fish and wildlife of the Alaskan wilderness attract hundreds of sports fishermen, hunters, and photographers each year. The water resources of the State provide a great deal of the scenery, and the lakes and rivers are frequently the means of transportation to or within the wilderness or backcountry. There are nearly

as many tourists visiting Alaska each year as there are residents. The need to wisely manage the water resources to provide for the tourist and recreationist is apparent.

It is anticipated that for the next 25 years Alaska will continue to experience growth in population and industry. Growth in the fishing and forest industries is expected to become stable and steady, while significant growth is anticipated in energy and minerals.

Conclusions and Recommendations

This section contains the conclusions developed in the course of the assessment on the severity and magnitude of water and related land problems along with recommendations for the resolution of these problems. The recommendations are expressed in terms of the need for planning, research and data collection, changes in institutional or legal arrangements, and the degree and nature of Federal, State, and local roles in solving these problems.

General

Planning efforts should address established priorities in a timely and effective manner. It is important that a program like the Water Resources Council's Comprehensive Coordinated Joint Planning (CCJP) be established for Alaska. It is essential to give early attention to developing decisions for carrying out such a program.

The program should include, among other things:

- State provision of some type of governmental structure to assist water and related land planning in remote communities and areas in unorganized boroughs
- Community planning that addresses the need for water and waste-disposal systems in all areas
- Planning that provides a sound financial basis for operation and maintenance of village water and waste-disposal systems.

With respect to the data base, it is necessary to proceed from the present situation of limited "spot" data through definition of the resources involved and a regional data system that can be used as a basis for management of water resources and analysis of impacts.

In terms of near-future priorities for planning and data purposes, significant controversy should be anticipated on water and related land aspects of mineral and energy development, the various proposals for new conservation set-asides, and on the issues of riparian water rights. This is particularly relevant in the case of the significant energy development proposals and the question of public use of waters flowing through private lands.

Attention must also be given to appropriate mechanisms for water planning and management in the various regions of the State, taking full advantage of local government studies but considering also the needs for regions of the State which do not yet have local government structures.

Needs for water use and development have been identified in the areas of municipal and industrial water supplies, port development, hydroelectric power, and enhancement of natural flow for fish and wildlife resources.

Priorities must be developed on the data and planning programs that will provide the basis for decisions on these matters. A very high priority should be given to the development of a State water plan for Alaska. The Southcentral Alaska Level B Study should proceed expeditiously to develop recommendations on an organizational structure and methodology for developing the State water plan through multiobjective, multidisciplinary water and related land-resource planning.

Federal-State-Local Role

Federal policies and programs which impose limitations on the State in terms of socioeconomic growth, natural resource development, and environmental programs should carry with them Federal responsibility and commitment to accept the public costs.

Recommendations - Remote village water

- The Federal Government, through the U.S. Public Health Service and the Environmental Protection Agency and other appropriate entities should provide financial and technical assistance to develop water supply system technologies and techniques for remote villages.

- The State Government should provide planning, and technical assistance, and financing programs to the communities for water supply and waste disposal.

- The regional and village native corporations should assume a strong role in providing support for water supply and waste-disposal techniques, whenever possible, and encourage the training of personnel to operate and maintain any necessary facilities.

Recommendations - Instream water

- The State should develop a minimum streamflow rationale using Federal expertise and guidance from the Instream Flow Work Group at Fort Collins, Colorado.

- Federal funding should be made available to the State for assistance in development of an evaluation system that is compatible with water regulation processes for putting an adequate instream use protection system into practice.

- The State should take the lead in the identification and coordination of joint Federal, State, and local hydrologic data gathering in priority areas.

Recommendations - Energy

- The State should develop a policy for energy development on those lands selected under the Statehood Act and on lands acquired under

the Submerged Lands Act, so that water-related impacts can be anticipated and mitigated. The results of the Alaska Public Forum are providing some guidance for State policy in this area.

- o Localities that actively seek energy facilities and their related jobs and growth must anticipate the effects the growth will have on regional water supplies and water quality and be prepared to bear a fair share of the public service costs associated with their actions.

Recommendations - Water availability

- o Increased State-community leadership is necessary and should be developed in regulating withdrawal and use of surface or ground waters to avoid depressed ground-water levels or undesirable levels of withdrawal from surface waters.

- o The State should maintain leadership in statewide water resources planning and should expeditiously develop a State water plan.

- o The State should ascertain and enforce, where appropriate, applicable water quality standards for maintenance of maximum water availability.

Recommendations - Flooding

- o Coordinated State, Federal, and local agency programs should be developed to identify areas of flood hazard and to implement flood-plain management techniques including control of flood-tolerable activities in flood-susceptible areas.

- o Emergency aid should be made available to alleviate flood damages and measures should be taken to restrict travel in danger areas during periods of flood threat.

Recommendations - Navigation, navigability, and ports

- o The Corps of Engineers should develop a program for identification of river navigation hazards and for river improvements.

Planning

A wide variety of planning, research, and data-type study needs were identified during the assessment. The following recommendations are based on a first look at these needs.

The planning process should be streamlined whenever possible, but participation by the public should not be excluded. The first Level B Planning Study for Alaska was authorized as a new start in FY 1977 and covers the southcentral hydrologic subregion of the State.

It is recognized that additional Alaskan Level B Studies may be desirable and justifiable in the future, and that some of the concerns identified during the assessment may become candidates for such studies. However, at this time the Alaska Water Study Committee does not recommend new Level B Study areas.

Recommendations - Remote village water

- Planners, engineers, and government officials must recognize that no single solution exists for remote village water supply and waste disposal, because the communities have different physical and social environments as well as different levels of financial capability.

- Current and future village water needs must be documented, i.e., where to obtain water, the type of treatment it will require, and how to dispose of both liquid and solid sewage wastes.

- The suitability of various systems for particular application should be understood prior to developing water supply or waste disposal facilities.

- Sophistication of water and waste systems should match the communities' ability to operate and maintain the system. Information on cost of a facility, including initial capital, maintenance, and operation should be made available to allow villagers to better understand long-range cost differences.

Recommendations - Instream water

- Coordination should be established with the Instream Flow Work Group, based in Fort Collins, Colorado. The group's expertise and training programs should be used to help develop an Alaska minimum streamflow classification and planning system.

- Identification, evaluation, and implementation of appropriate State-Federal-local action should be undertaken to alleviate instream conflicts in existing or potential problem areas.

Recommendations - Energy

- Planning that recognizes the State and national needs for energy, particularly oil, gas, and coal, and the need for safeguarding the environment should be accomplished by the State and Federal Governments in partnership.

- To better manage regional waters and lands, planning must take into account the aggregate effects of several energy activities occurring in overlapping time frames, rather than only considering projects on an individual basis.

- Planning for energy-related water needs and impacts must take into account national and international economics, and projections must be developed to deal with the variety of scenarios possible under different market conditions for oil, gas, coal, hydropower, and other energy sources.

- Siting coordination to use waste process heat in aquaculture and greenhouses should be practiced by appropriate private and public parties.

Recommendations - Water availability

- The State of Alaska must continue to exercise leadership in the development of a comprehensive State water plan for utilization, conservation, development, and control of the State's water and related land resources to serve diverse purposes.

- Planning for water use must consider the effect of use of a source on other occurrences of water, particularly instream requirements, lake levels, high water tables (wetlands), and prior appropriators.

- Village development and planning must take into consideration the availability of water prior to the development and initiation of large-scale water demand plans.

- Extensive hydrologic studies to describe natural and potential ground-water movements must be made at sites for refuse disposal. Provisions should be made for continual monitoring of these sites after use is initiated.

- Cooperative assistance of the Alaska Department of Environmental Conservation may be warranted in relocation and/or management of refuse disposal areas to ensure water quality and reduce related problems.

Recommendations - Navigation, navigability, and ports

- A program for the phased development of adequate port facilities, anchorages, etc., should be developed as part of the State water plan.

- Studies should be delineated and scheduled to determine the navigability of streams in the State.

Data and Research

The lack of specific data on water and related land resources in areas of potential utilization, conservation, development, and control is critical in many parts of the region. Data that are available are generally limited to the more populated areas of the region; existing data in the rural

areas appear to be too general in nature to use with any degree of certainty. Even in the most populous areas the available data base is fragmentary and inadequate.

Surface- and ground-water availability and quality data lack adequate definition and content for planning purposes in specific geographic areas. Although much of the State is still uninhabited, there is currently an immediate need for data that will provide the base for planning and regulatory functions.

Recommendations - Remote village water

- Appropriate agencies should establish regular monitoring of water quality in remote villages. The water should meet current applicable State water quality standards.

- More information should be developed on pathogen movement and decay in permafrost soils and cold waters.

- Field studies should be made to locate suitable ground-water supplies and to determine streamflow, lake storage, and reservoir storage.

Recommendations - Instream water

- A methodology should be developed to evaluate instream flow needs for aquatic life and other purposes, including water quality management, hydroelectric and energy developments, waterborne transportation, recreational use, and other functions or uses. This research must consider all minimum flow characteristics necessary to maintain existing and future instream uses. The methodology must be adaptable for use as part of the planning, administrative, and regulatory activities of government agencies.

- A coordinated statewide data-gathering network should be established and operated which can provide basic hydrologic data for instream flow evaluation as well as other water resource concerns.

Recommendations - Energy

- The baseline hydrologic data needed to make satisfactory development decisions on nearly all Alaskan energy resources, with the exception of some hydroelectric sites, is severely lacking and should be developed and coordinated with a statewide hydrologic data-gathering network.

- The interrelationships between any aquifers and surface waters in areas of potential strip mining are unknown. It should be determined if coal seams act as aquifers in Alaskan coal fields as they do in some Montana and Wyoming coal regions.

- The effect of mining on water quality is unknown. Extensive research studies should be undertaken in proposed strip-mine areas

to develop predictive data on the effects of mining on water quality.

- o Water needs for surface reclamation of mined areas in Alaska's several climatic regions are not known. Satisfactory species of plants for reclamation may need to be identified before this can be determined.

- o Further field studies should be made to identify alternative water supplies and storage possibilities which can supply year-round water, particularly on the North Slope.

- o Research should be undertaken to develop cheaper methods of utilizing geothermal energy in remote villages.

- o Research is needed and should be programmed to develop practical applications of recycling of waste from generating facilities and industrial processes for such uses as warming supplies from cold surface and ground waters and to support aquaculture and greenhouse operations.

Recommendations - Water availability

- o Studies should be made to define predictable qualitative and quantitative relationships among the runoff, climate, and cold-region geology aspects of water availability, especially in permafrost areas.

- o Beneficial and adverse evaluations should be made of cold-region water resources and hydrology in terms of the significance of low-temperature water in meeting availability criteria in permafrost regions.

- o A complete quantitative and qualitative inventory and analysis of well logs and data should be made to predict total water availability and to describe the occurrence and movement of water.

- o Coordinated studies should be undertaken by the Institute of Water Resources, Alaska Division of Geological and Geophysical Surveys, and/or U.S. Geologic Survey to adequately define limits of groundwater quality hazards and to improve knowledge required for a ground-water management plan. In some areas of the State (e.g., the Anchorage Bowl and Kenai Peninsula), population demand is such that these studies assume a high priority.

- o Hydrologic and related land data should be gathered, along with the foregoing inventories and studies to form an adequate data base to develop and manage the surface water, ground water, and related land resources.

Recommendations - Flooding

- o A number of alternatives in flood-plain management should be con-

sidered. Appropriate combinations of structural and nonstructural measures should be developed that:

a. Modify the susceptibility to flooding by such measures as land-use regulation, open space acquisition; establishing building codes, zoning, and developmental policies; floodproofing existing buildings in the flood plain; obtaining real time data for flood forecasting or flood warning; and structural measures, where necessary, to complement nonstructural measures.

b. Modify the consequence of flooding through use of flood hazard information efforts, flood insurance, tax adjustments, emergency assistance, or flood relief insurance.

- Coastal and river flood-plain communities subject to flooding should be examined to determine the need for flood-control structures versus moving the communities.

- The effects of proposed flood-control measures must be determined prior to implementation.

- Studies should be made of ground-water availability, quality, fluctuation, flood hazard areas, and vegetation analysis for range management.

Institutional Arrangements

Alaska is currently in the transition phase of large-scale land transfers from Federal to State Government ownership under the Alaska Statehood Act and to private ownership under the Alaska Native Claims Settlement Act (ANCSA). The future for the management and planning of Alaska's waters will in large measure be guided by the resolution of land ownership uncertainties. The institutional implications of the final disposition are fundamental.

Additionally, institutional and legal concerns are in evidence relative to the ownership of rivers, riverbanks, lake beds, the coastal zone, and jurisdiction over water rights. There are also unanswered questions and problems having to do with water ownership, navigability, water quality standards, and access.

Recommendations - Remote village water

- Coordinated, well-directed financial and service installation assistance should be made available that is compatible with villages' ability to continue the programs on their own.

- Education in sanitary and personal hygiene and improved medical care should be made available to contribute to better public health.

Recommendations - Instream water

- o The State should enact legislation to clarify the issue of reserving waters for instream use under the Water Use Act, AS 46.15.

- o Provision of instream-use protection as well as permit and regulatory programs at all governmental levels must be integrated with the relevant planning and analysis and activities.

Recommendations - Energy

- o More effective enforcement of existing laws and regulations should be undertaken to safeguard the environment during exploration, production, and transportation of energy to market.

- o Planning activities for development of energy resources on Federal, State, and private lands should be integrated with the regulatory and administrative processes under the authorities of the respective agencies.

Recommendations - Water availability

- o Water conservation must be encouraged for all consumptive water users.

- o State or Federal regulation of water use should be considered as a method of ameliorating water shortages.

- o Tighter agency regulation of water and air discharges, and sand-gravel removal operations should be undertaken to maintain the amount of water available.

- o Realistic arrangements for financial support of village water supplies and waste disposal facilities should be made prior to their installation.

- o Adequate, coordinated land-management practices should be utilized in conjunction with enforcement of current regulations to protect or minimize the potential degradation of Alaska's waters and adjacent lands and wetlands from development of transportation corridors and development of mineral and petroleum resources.

Recommendations - Navigation, navigability, and ports

- o Federal, State, and private entities should proceed with a coordinated effort to define navigability and develop a program for applying that definition to the waters of Alaska.

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The United States Water Resources Council was established by the Water Resources Planning Act of 1965 (Public Law 89-80). The purpose of the Council is to encourage the conservation, development, and utilization of water and related land resources on a comprehensive and coordinated basis by the Federal government, States, localities, and private enterprises with the cooperation of all affected Federal agencies, States, local government, individual corporations, business enterprises, and others concerned.

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